

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/324961854>

Elements of Phonological Interventions for Children With Speech Sound Disorders: The Development of a Taxonomy

Article in *American Journal of Speech-Language Pathology* · May 2018

DOI: 10.1044/2018_AJSLP-17-0127

CITATIONS

7

READS

4,186

4 authors, including:



Elise Baker

Western Sydney University

64 PUBLICATIONS 985 CITATIONS

[SEE PROFILE](#)



Lynn Williams

East Tennessee State University

25 PUBLICATIONS 565 CITATIONS

[SEE PROFILE](#)



Rebecca Mccauley

The Ohio State University

36 PUBLICATIONS 738 CITATIONS

[SEE PROFILE](#)

Some of the authors of this publication are also working on these related projects:



Toddler Word Learning [View project](#)



Evaluation of a cross-situational statistical word learning intervention with late talking toddlers. [View project](#)

Clinical Focus

Elements of Phonological Interventions for Children With Speech Sound Disorders: The Development of a Taxonomy

Elise Baker,^a A. Lynn Williams,^b Sharynne McLeod,^c and Rebecca McCauley^d

Purpose: Our aim was to develop a taxonomy of elements comprising phonological interventions for children with speech sound disorders.

Method: We conducted a content analysis of 15 empirically supported phonological interventions to identify and describe intervention elements. Measures of element concentration, flexibility, and distinctiveness were used to compare and contrast interventions.

Results: Seventy-two intervention elements were identified using a content analysis of intervention descriptions then arranged to form the Phonological Intervention Taxonomy: a hierarchical framework comprising 4 domains, 15 categories, and 9 subcategories. Across interventions, mean element concentration (number of required or optional elements) was 45, with a range of 27 to 59 elements. Mean flexibility of

interventions (percentage of elements considered optional out of all elements included in the intervention) was 44%, with a range of 29% to 62%. Distinctiveness of interventions (percentage of an intervention's rare elements and omitted common elements out of all elements included in the intervention [both optional and required]) ranged from 0% to 30%.

Conclusions: An understanding of the elements that comprise interventions and a taxonomy that describes their structural relationships can provide insight into similarities and differences between interventions, help in the identification of elements that drive treatment effects, and facilitate faithful implementation or intervention modification. Research is needed to distil active elements and identify strategies that best facilitate replication and implementation.

Numerous interventions for children with speech sound disorders (SSD) have been developed over the past 100 years (e.g., Swift, 1918) to offer clinicians effective approaches for addressing the needs of children ranging from those who demonstrate a few residual speech errors to those with severe unintelligibility. These interventions have been disseminated through tutorial and empirical articles, workshops and book chapters, and even entire books dedicated to specific interventions (for a summary, see E. Baker & McLeod, 2011; McLeod & Baker, 2017; Williams, McLeod, & McCauley, 2010). Developers' accounts of these approaches reflect their ideas about the elements that comprise and contribute to the efficacy of

their approach, such as goals, teaching procedures, and evaluation strategies. In this context, elements are fundamental building blocks of an intervention that characterize an approach. Clear and explicit description of these elements enables faithful replication and implementation. Clear description also helps clinicians make informed choices given the diversity of approaches on offer.

The purpose of this article is twofold—first, to report on the development of the Phonological Intervention Taxonomy to identify the elements of well-studied pediatric phonological interventions and, second, to illustrate how the taxonomy could help increase the transparency of intervention descriptions, thereby supporting clinical training and research into the contribution and necessity of intervention elements. We selected phonological interventions rather than articulatory or motor speech interventions because they represent the largest group of interventions currently available for children with the most common type of SSD—phonological impairment (E. Baker & McLeod, 2011). In this introduction, we explain the importance of clarity in intervention descriptions, consider how clarity can be addressed

^aDiscipline of Speech Pathology, Faculty of Health Sciences, The University of Sydney, New South Wales, Australia

^bEast Tennessee State University, Johnson City

^cCharles Sturt University, Bathurst, New South Wales, Australia

^dThe Ohio State University, Columbus

Correspondence to Elise Baker: elise.baker@sydney.edu.au

Editor-in-Chief: Krista Wilkinson

Editor: Kristie Spencer

Received August 17, 2017

Revision received January 2, 2018

Accepted January 29, 2018

https://doi.org/10.1044/2018_AJSLP-17-0127

Disclosure: A. Lynn Williams, Sharynne McLeod, and Rebecca McCauley are co-editors of the book *Interventions for Speech Sound Disorders in Children*, published by Paul H. Brookes Publishing, as referred to in the manuscript, and receive royalty payments on the sale of the book. Elise Baker has declared that no competing interests existed at the time of publication.

through *a priori* (top-down) and *a posteriori* (bottom-up) strategies, and reflect on the state of phonological interventions for children with SSD with respect to replication and diversity. In doing so, we establish the need and a methodology for the development of the Phonological Intervention Taxonomy.

The Importance of Clarity in Intervention Descriptions

All stages of intervention development (Fey & Finestack, 2009) and clinical application (Kaderavek & Justice, 2010) require clear descriptions of the many aspects of an intervention, from the methods used to identify, assess, and describe individuals receiving the intervention (Hammer, 2011; McCauley & Demetras, 1990) through to the elements that comprise the intervention itself. Clarity in these descriptions is important for four key reasons.

First, clarity promotes replicability, a bedrock concept of modern scientific methods (Plutchik, 1983). The paramount importance of replication is underscored by methodologists who argue that claims made on the basis of single studies should be interpreted cautiously (M. Baker, 2015; Ioannidis, 2005), especially when samples are small and likely to be biased by the reporting of only positive or selected outcomes. Recently, commitment to the importance of replications has intensified across many disciplines because large-scale replication efforts are demonstrating that single studies, even those of very high quality, may not be replicable. In a groundbreaking replication of 100 research findings in psychology, only 39 key findings were fully reproduced in direct replications of study designs (M. Baker, 2015; Open Science Collaboration, 2015). Similarly, in medicine, Ioannidis (2005) examined the results of relatively loose replications (i.e., studies in which the same research questions were addressed) and found that the process resulted in modifications to previous evaluations of the direction, strength, and meaning of observed effects. More recently, Ludemann, Power, and Hoffmann (2017) examined the replicability of randomized controlled trials across 162 speech-language pathology interventions. Using the Template for Intervention Description and Replication checklist (Hoffmann et al., 2014), Ludemann et al. (2017) reported that none of the articles rated had sufficient detail to enable replication. Although searches for additional information (e.g., protocol papers, websites, contact with authors) yielded more detail, the overall finding was that intervention elements were inadequately described. Regrettably, although the need for replication is often taken as axiomatic, it would seem that replications are largely absent or often may not be possible (given insufficient intervention descriptions) in educational and behavioral research (Makel & Plucker, 2014; Malouf & Taymans, 2016) and speech-language pathology (Ludemann et al., 2017; Muma, 1993).

In the area of speech sound interventions, E. Baker and McLeod (2011) conducted a narrative review of 134 peer-reviewed studies of phonological interventions for children with SSD and identified 46 different phonological

intervention approaches. Only half of these ($n = 23$) had been studied and reported in more than one publication, and exact replications were limited both in number and diversity of authors. For example, although minimal pairs therapy was investigated in 42 studies by 21 different groups of researchers (E. Baker & McLeod, 2011), lack of consensus on the ideal combination of elements comprising the approach and insufficient methodological detail (i.e., lack of clarity) meant that few of the studies of this approach could be considered direct replications (E. Baker, 2010). Without increases in the clarity of methodological description (including the elements that comprise the interventions), replication research on this topic will remain sparse and, even when undertaken, will likely be flawed.

A second reason that clarity or transparency in intervention descriptions is of prime importance is its role in establishing intervention integrity (also known as *fidelity* or *procedural reliability*). *Intervention integrity* refers to “the extent to which essential intervention components [i.e., elements] are delivered in a comprehensive and consistent manner by an interventionist trained to deliver the intervention” (Sanetti & Kratochwill, 2009, p. 448). Credible, data-driven statements about the integrity of an intervention help to bolster claims about relationships between the independent and dependent variables (internal validity) and generalizability (external validity). Studies using an intervention with high integrity allow research consumers to be confident that reported outcomes are based on the intervention rather than on uncontrolled variables. Of course, the very idea that an intervention can be implemented in the intended manner is predicated on an assumption that the elements of an intervention have been made explicit.

Third, clear description of interventions allows researchers to study the effect of particular elements, with multiple benefits. It allows researchers to identify and separate essential from supplementary elements, with essential elements being those critical for success (Abry, Hulleman, & Rimm-Kaufman, 2015; Sanetti & Kratochwill, 2009). It can help researchers identify and modify elements so that they are more effective or adapt elements so that they are more amenable to real-world adoption, implementation, and maintenance and are less susceptible to breakdowns along the multistep path to widespread use (e.g., Dingfelder & Mandell, 2011; Embry & Biglan, 2008). Research examining the effect of specific elements also allows researchers to explore the cost effectiveness of different groups of elements and to distil or refine approaches by identifying and removing elements of no consequence. Often referred to as *component analysis*, such research often has been conducted using single subject experimental designs (Ward-Horner & Sturmey, 2010), but group designs have also been used for this purpose (Abry et al., 2015).

Finally, clear and detailed descriptions are central to speech-language pathologist (SLP) training and ongoing continuing education (Dijkers, 2015; Michie et al., 2011). They help clinicians understand what is required

for implementation and determine what knowledge, skills, and/or resources they already have and/or what they need to acquire to faithfully implement an approach. Clear and detailed descriptions may also help clinicians engage in more informed and systematic modification of interventions to address client needs and preferences than current “eclectic” modifications reported to be used by SLPs (Brumbaugh & Smit, 2013).

A Priori Versus A Posteriori Knowledge

What do we know about phonological interventions and the elements they comprise? A helpful way of thinking about this question is to think about the origins of knowledge. Based on the work of the German philosopher Immanuel Kant (1724–1804), there are two paths from which knowledge can emerge—knowledge can be *a priori* and *a posteriori* (Müller-Merbach, 2007). *A priori* knowledge emerges from the mind, through deductive reasoning. It can arise from predetermined theories or a set of ideas without experimental foundation. By contrast, *a posteriori* knowledge comes from our sensory experience of the world (Müller-Merbach, 2007). It emerges from experimentation and observation. To appreciate the difference between these two sources of knowledge, consider the following scenario. If a novice clinician was asked to think about what teaching procedures might help a child produce a contrast between plosives and fricatives in words, the novice clinician could generate ideas, that is, *a priori* knowledge. If the same novice clinician was asked to observe an experienced clinician conduct a minimal pairs intervention session targeting stopping of fricatives, the novice clinician could describe what was said and done—that is, generate *a posteriori* knowledge from observation. Both types of knowledge are important for informing our understanding of intervention elements.

The A Priori (Top-Down) Description of Intervention Elements

Over the past decade, the issue of clarity in research descriptions has been addressed through predetermined guidelines and checklists provided by organizations tasked with the improvement of research quality. The highly influential Consolidated Standards of Reporting Trials (CONSORT) statement was prepared to offer guidelines for the reporting of randomized controlled trials (Moher, Schulz, Altman, & the CONSORT Group, 2001; Schultz, Altman, Moher, & the CONSORT Group, 2010), with medical researchers as the primary audience. In 2004, a related document, the Transparent Reporting of Evaluations of Non-Randomised Designs (TREND) statement (Des Jarlais, Lyle, Crepez, & the TREND Group, 2004) offered similar guidelines but for nonrandomized studies, such as those frequently used in studies of behavioral and public health, rather than medical interventions.

The Journal Article Reporting Standards (JARS), which appear in the sixth edition of the *Publication Manual of the*

American Psychological Association (American Psychological Association, 2010), are built upon the CONSORT and TREND statements. For journal articles in which an experimental manipulation or intervention is studied, the JARS stipulate eight relevant topics related to intervention description: intervention content, method of intervention delivery, deliverer, setting, exposure quantity and duration, time span, and activities to increase compliance or adherence (e.g., incentives). In addition, authors need to specify the language used (other than English) and translation method. For example, the topic “time span” is described as “how long it took to deliver the intervention or manipulation to each unit” (American Psychological Association, 2010, p. 249). These various sets of standards or predetermined ideas about the type of information that should be included in intervention descriptions are among many that are being developed by professional and scholarly communities to improve our knowledge about interventions of all kinds.

Additional methods for ensuring clarity in intervention descriptions include manualization and the systematic documentation of intervention integrity (e.g., Eifert, Schulte, Zvolensky, Lejuez, & Lau, 1997; Kaderavek & Justice, 2010). Manualization involves the transformation of an intervention idea or prototype into a robust replicable solution that enables reliable implementation by others. Manualization requires explication of elements comprising a specific intervention approach, such as the goals (i.e., what is targeted), procedures (i.e., how goals are addressed), expected responses from children (i.e., children listen to and/or produce speech), and intervention intensity (i.e., session dose, frequency, duration, and total intervention duration; E. Baker, 2012; Warren, Fey, & Yoder, 2007). Manualized interventions typically comprise written guidelines or a manual and, if need be, training and resources. Once prepared, intervention manuals can be used during efficacy and effectiveness studies and, later, during implementation (e.g., McCartney et al., 2004). Manualization also permits the systematic documentation or recording of how well a clinician implements an intervention.

Although not used to guide intervention research in the same way as an intervention manual, variations on a structural model of intervention developed by Fey et al. (Fey & Finestack, 2009; McCauley & Fey, 2006; McCauley, Fey, & Gillam, 2017) have been associated with several books describing interventions in communication disorders (e.g., Guitar & McCauley, 2010; Prelock & McCauley, 2012; Williams et al., 2010). Many of these interventions are also represented in part by accompanying video content—combining *a priori* with *a posteriori* knowledge. Unlike manualized interventions that make clear how to implement specific intervention approaches, structural models provide a framework of the generic elements that might comprise interventions. In McCauley and Fey (2006), the model components or elements consisted of intervention agents, intervention contexts, intensity, procedures, activities, measurement of outcomes, goal attack strategies, and three

components related to goals that were differentiated by their level of abstraction (i.e., basic, intermediate, and specific). In a subsequent revision of the model (McCauley et al., 2017), service delivery models were added as an additional element.

In addition to intervention manuals and structural models, promotion of intervention integrity or fidelity can involve methods, such as the use of a procedural checklist (e.g., Dijkers, 2015; McIntyre, Gresham, DiGennaro, & Reed, 2007) and behavioral observation of clinicians using an intervention, to ascertain that predetermined elements are being used and implemented in accordance with developers' *a priori* intentions (Kaderavek & Justice, 2010). Procedural checklists itemize the methods described in an intervention manual as a means of promoting integrity of implementation or fidelity. In contrast to comprehensive manuals, procedural checklists outline important or key elements of an intervention. However, all of these strategies—manuals, structural models of intervention, and checklists—almost always fail on central questions related to how elements of an intervention contribute to outcomes (Dijkers, 2015).

Consequently, another approach to the improved descriptions of interventions has arisen that is more discipline- and practice context-specific and, explicitly, more theoretically driven. This approach involves the development of intervention classification systems or taxonomies built with primary attention to theory, in particular to theories about how interventions work. For example, in 2016, Turkstra, Norman, Whyte, Dijkers, and Hart introduced the speech-language pathology audience to the rehabilitation treatment taxonomy (RTT), a classification system being developed in the rehabilitation literature (e.g., Dijkers, Hart, Whyte, Zanca, Packel, & Tsaousides, 2014; Whyte, Dijkers, Hart, Zanca, Packel, Ferraro, & Tsaousides, 2014).

Treatment theory—a theory about how and why an intervention works—is seen as central to the development of the RTT (Turkstra et al., 2016). In the RTT, intervention consists of measurable ingredients (i.e., clinician's actions that can range from the use of a device to environmental modifications to modeling and prompting) that act upon measurable treatment targets through a mechanism of action (known or hypothesized). Of particular interest is the distinction between active versus inactive ingredients, with inactive ingredients being those that are included in an intervention but may not contribute to effects on a particular target. In the RTT, for each target, the relevant ingredient associated with the means of action comprises a treatment component. Aims are described as the ultimate functional outcomes resulting from the achievement of one or more targets, for example, they give the example of improved conversation as an aim that may require different treatment components. This distinction is similar to that associated with the several levels of goals (basic, intermediate, specific) in existing models in speech-language pathology (e.g., McCauley et al., 2017).

The A Posteriori (Bottom-Up) Search for Intervention Elements

In contrast to *a priori* descriptions of intervention elements, researchers across many applied social and behavioral sciences, such as clinical psychology, nursing, health promotion, and education, have identified and described elements *a posteriori* (e.g., Abraham & Michie, 2008; Dunst, Raab, & Trivette, 2011; Embry & Biglan, 2008; Michie, Fixsen, Grimshaw, & Eccles, 2009). That is, they identified elements through observation and/or reading empirically based information without the guidance of *a priori* procedural checklists. In this way, the problem of circularity or describing an intervention by the elements detected from a list to the detriment of failing to detect elements not on a list can be mitigated.

To date, few such efforts have been undertaken in communication disorders. For example, Andrews, Guitar, and Howie (1980) conducted a meta-analysis of 42 studies of techniques used to improve stuttering and attitudes in persons who stutter. They found that prolonged speech and gentle onset techniques produced better long-term (6 months post therapy) and short-term outcomes than techniques that focused on attitude or airflow. In another example, Dunst et al. (2011) used content analysis to identify the elements (referred to as characteristics) of six naturalistic language intervention approaches. Dunst et al. identified three broad characteristics (child, adult setting, and adult characteristics) across the approaches and 11 features within these broad characteristics (e.g., caregiver responsiveness, joint interactions, child engagement). They further unpacked the approaches identifying 32 elements, coding the explicit presence (+), implied presence (–), or absence (0) of each element for each approach. In doing so, they identified the potential key elements of naturalistic language interventions. These two examples illustrate the value of using an *a posteriori* strategy to identify the elements of interventions.

Most recently, Van Stan, Roy, Awan, Stemple, and Hillman (2015) created a taxonomy of voice therapy using *a priori* and *a posteriori* strategies. Van Stan et al. set out to develop a taxonomy that was concise, accurate, made use of a dictionary/thesaurus as a way of standardizing terminology, and drew on previous categorical descriptions of therapy (e.g., direct vs. indirect interventions). Further, the authors intended to define a taxonomy that could be used to describe “what happens during a voice therapy session” (p. 103), indicating that the taxonomy would allow for a temporally changing description of the variety of elements occurring within or across multiple sessions. As a means of demonstrating the utility of their taxonomy, Van Stan et al. used portions of it (specifically, their subcategorization of direct interventions by vocal subsystem) to characterize and compare seven well-known therapy programs on the basis of descriptions of them in peer-reviewed articles and relevant review articles. In their discussion, Van Stan et al. noted the potential educational and clinical value of structured descriptions on the basis of their taxonomy.

Perhaps, because the decision methods used in this undertaking were reportedly based on consensus, the reliability of descriptions on the basis of the taxonomy was not evaluated. Nonetheless, this article represents an important step forward in the rigorous development of taxonomies for speech-language pathology interventions using both data and theory.

In summary, whereas *a priori* descriptions of intervention structure have largely been recommended or undertaken to aid in the clarity of descriptions of specific interventions, *a posteriori* efforts to identify elements can lead to powerful advances in the systematic comparison of interventions intended for specific populations or to address specific skills. By identifying shared and distinct elements, such efforts may offer consumers a clearer idea of the real alternatives presented by superficially similar interventions, researchers a clearer idea of which elements deserve greater scrutiny, and educators a clearer idea of how best to facilitate learners' faithful implementation of intervention elements.

Thus, in order to advance an examination of intervention structures in phonological interventions, we report on a qualitative study, then on the use of its findings to describe interventions. Specifically, we describe the development of a Phonological Intervention Taxonomy on the basis of an *a posteriori* description of the elements from a group of empirically supported phonological intervention approaches for children with SSD. Textual descriptions of the interventions were used as input to that process. Second, we use the taxonomy to offer a broad overview of the 15 studied approaches in terms of the number of elements used (i.e., concentration), the proportion of elements indicated as optional within each approach out of all included elements (i.e., flexibility), and the extent to which an intervention included rare or uncommon elements and omitted common elements out of all included elements (i.e., distinctiveness).

Method

Data Inclusion Criteria

Fifteen phonological intervention approaches were selected to develop a Phonological Intervention Taxonomy (see Table 1 and reference list*).¹ They were selected because they were supported by peer-reviewed experimental evidence, and they each had been described in a chapter

¹Intervention approaches included in the review are identified in this clinical focus article by capitalization of the first letter of each word (e.g., Multiple Oppositions [Williams, 2010]), or where relevant the customary acronym (e.g., Parents and Children Together = PACT [Bowen, 2010]; Enhanced Milieu Teaching with Phonological Emphasis = EMT/PE [Scherer & Kaiser, 2010]). Camarata (2010) describes two approaches to naturalistic speech intervention: Naturalistic Intervention for Speech Intelligibility (NISI) and Naturalistic Intervention for Speech Accuracy. Only NISI was included in the review.

published by Williams et al. (2010). Each chapter had been written by, in most cases, an author who had played an important, even principal role in the development of the approach. Each chapter had been written according to a prescribed template that defined specific information to be included in sections marked by specified headings and subheadings along with associated page limits (see Appendix A). Although the relatively rigid format of the chapter template had originally been intended to provide an *a priori* description of key intervention elements, the methods used in the content analysis reported on here was intended to avoid the simple reproduction of the template elements as elements.

Researchers

In keeping with requirements of rigor in qualitative research methodology (Lincoln & Guba, 1985), the researchers' potential sources of bias warrant acknowledgment. Each of the four researchers has worked with and conducted research into children with SSD for over a decade or more and has also spent considerable time writing, reading, and reviewing research on interventions for this population, including as authors and editors of Williams et al. (2010). Methods used to limit the impact of researcher preconceptions will be described in the procedural descriptions that follow.

Procedure

The research was undertaken in two phases. Phase 1 involved a qualitative thematic analysis using an interpretivist approach (Hatch, 2002; Yin, 2011) to isolate meaning statements reflecting possible intervention elements. This phase was undertaken in order to identify and construct the Phonological Intervention Taxonomy. Phase 2 was an analysis of each intervention chapter's text to determine whether the elements in the taxonomy were required, optional, or absent (not present and/or not explicitly mentioned) for each of the 15 approaches.

Phase 1: Content Analysis to Identify Elements

The content analysis entailed nine steps to identify intervention elements. These steps involved identification of meaning statements within text describing each intervention, combining related statements, and organizing them into a hierarchy of thematic domains, categories and subcategories, and elements (Yin, 2011). (1) Chapter text contained under the headings "Practical Requirements" and "Key Components" for each of the 15 studied phonological intervention approaches from Williams et al. (2010; see Appendix A) was combined into a single electronic document. (2) The first three researchers collaboratively read one intervention approach and highlighted meaning statements. A *meaning statement* was defined as a unit of information conveying one idea. A meaning statement could comprise one word within a sentence, a short phrase, a sentence, or series of sentences, as long as the written information

Table 1. Characterization of the 15 interventions included in the current review in terms of concentration, flexibility, and distinctiveness.

Intervention approaches ^a	No. of elements coded as required (and optional) ^b	No. of rare elements included (and common elements omitted) ^c	Concentration ^d	Flexibility ^e	Distinctiveness ^f
Complexity (Complexity Approaches to Intervention; E. Baker & Williams, 2010)	24 (14)	3 (0)	38	37%	3/38 (8%)
Core Vocabulary (Core Vocabulary Intervention; Dodd et al., 2010)	27 (15)	1 (0)	42	36%	1/42 (2%)
Cycles (The Cycles Phonological Remediation Approach; Prezas & Hodson, 2010)	32 (15)	1 (0)	47	32%	1/47 (2%)
Dynamic Systems (Dynamic Systems and Whole Language Intervention; Hoffman & Norris, 2010)	30 (12)	2 (0)	42	29%	2/42 (5%)
EMT/PE (Enhanced Milieu Teaching with Phonological Emphasis for Children with Cleft Lip and Palate; Scherer & Kaiser, 2010)	27 (19)	2 (2)	46	41%	4/46 (9%)
Metaphonology (Metaphonological Intervention; Phonological Awareness Therapy; Hesketh, 2010)	27 (24)	1 (0)	51	47%	1/51 (2%)
Minimal Pairs (Minimal Pair Intervention; E. Baker, 2010)	22 (26)	2 (0)	48	54%	2/48 (4%)
Morphosyntax (Morphosyntax Intervention; Tyler & Haskill, 2010)	24 (18)	3 (2)	42	43%	5/42 (12%)
Multiple Oppositions (Multiple Oppositions Intervention; Williams, 2010)	26 (25)	1 (0)	51	49%	1/51 (2%)
Nonlinear (Nonlinear Phonological Intervention; Bernhardt et al., 2010)	18 (29)	0 (0)	47	62%	0/47 (0%)
NISI (Naturalistic Intervention for Speech Intelligibility; Camarata, 2010)	17 (13)	0 (7)	30	43%	7/30 (23%)
PACT (Parents and Children Together Intervention; Bowen, 2010)	36 (23)	1 (0)	59	39%	1/59 (2%)
Psycholinguistics (Psycholinguistic Intervention; Stackhouse & Pascoe, 2010)	25 (34)	3 (0)	59	58%	3/59 (5%)
Speech Perception (Speech Perception Intervention; Rvachew & Brosseau-Lapr�e, 2010)	13 (14)	2 (6)	27	52%	8/27 (30%)
Stimulability (Stimulability Intervention; Miccio & Williams, 2010)	29 (18)	3 (0)	47	38%	3/47 (6%)
Average	25 (20)	1.7 (1.1)	45	44%	2.8 (6%)

^aShort name of intervention in bold (used to refer to intervention throughout current article), followed by chapter title and author(s) in Williams et al. (2010). ^bElements coded as optional are shown in parentheses () next to elements coded as required. ^cOmitted common elements are shown in parentheses () next to rare elements. ^dTotal number of elements. ^ePercentage of elements coded as required over total elements. ^fTotal rare + omitted common elements/total elements per approach, with percentage shown in parentheses ().

contained only one idea. Most sentences contained at least one, and sometimes several, meaning statements. For example, this sentence from the Stimulability approach (Miccio & Williams, 2010, p. 189) was chunked into five separate meaning statements (emphasis added): “Use the [associated hand/body motions] to [bring their children’s attention to the target sounds] [at home] to [encourage speech production] within a [nonthreatening atmosphere].” This process of defining and identifying meaning statements was discussed and agreed upon by the first three researchers through the collaborative training process—reading and identifying individual meaning statements from the same chapter text, together. (3) The same three researchers then were randomly allocated with five intervention approaches each and independently chunked the text into meaning statements, retaining information about the source of the

statement. (4) Next, they independently categorized the individual meaning statements into what they saw as overarching themes of intervention. (5) At the next step, all four researchers met, including the three researchers involved in Steps 1–4, and shared the overarching themes they had identified. There were many consistencies between the identified themes of the three researchers, despite each considering different intervention approaches. (6) The group discussed the themes that had been identified and agreed on consolidating some themes while leaving others as originally identified by one of the coding researchers. In this way, an initial taxonomy was developed. (7) For each theme, the associated meaning statements were reviewed by the group to determine whether the appropriate categorization was made across all of the intervention approaches. For example, there were 120 meaning statements initially labeled

by the researchers as Parent education ($n = 47$), Family ($n = 49$), Homework ($n = 20$), Home practice ($n = 3$), and Home practice: technology ($n = 1$). After reconsidering these meaning statements within the broader intervention taxonomy, they were reclassified and hierarchically arranged into categories and subcategories. For example, a parent was considered to be a type of intervention agent, which was considered to be part of the overall intervention context. (8) The four researchers then tested the Phonological Intervention Taxonomy by locating exemplar quotes for each of the identified categories and elements. (9) To conclude Phase 1, the first researcher then read and identified intervention elements in a second source of literature for each intervention approach, a peer-reviewed published article (i.e., 15 articles), to determine if saturation of elements across the 15 phonological interventions had been reached. No new elements were identified in this step, as all identified elements could be classified using the taxonomy.

The final version of the Phonological Intervention Taxonomy is outlined in Figure 1. This taxonomy involves a branching framework that includes up to four levels. At the broadest level is *domain*, which provides the overarching organization or construction of the taxonomy and defines a major property of interventions in general. As shown in Figure 1, there are four intervention domains: *goal*, *teaching moment*, *context*, and *procedural issues*. The second level of the taxonomy, *category*, is a smaller self-contained constituent of a domain. For example, under the domain *teaching moment*, categories are *antecedent event*, *response*, and *consequent event*. The third level, *subcategory*, provides greater differentiation and is evident in two of the four broad domains (teaching moment and context). The final level, *element*, is the smallest building block of an intervention in this taxonomy. We chose the term *element* rather than ingredient to avoid the potential for confusion with the definition of ingredient by Turkstra et al. (2016, p. 165), namely, “specific actions taken by the clinician to effect changes in the target.” As such, elements encompass ingredients in addition to information about goals, intervention context, and other procedural aspects. Across the 15 categories and nine subcategories of the Phonological Intervention Taxonomy, 72 intervention elements were identified. Definitions and examples for all elements are provided in Appendix B.

Phase 2: Coding Analysis to Identify Elements

Once the Phonological Intervention Taxonomy was created, a 3-point scale was applied based on Dunst et al. (2011) to differentiate whether or not an element was part of the intervention approach. The 3-point scale allowed for an element to be coded as (a) required (score = 2), (b) optional (score = 1), or (c) absent (score = 0) in descriptions of each approach. In this way, each element was coded across the 15 intervention approaches. To be coded as required, the element had to be specified in the intervention (e.g., the element imitation was coded as required in the Complexity

approach given the statement, “a child is instructed to repeat the clinician’s model” [E. Baker & Williams, 2010, p. 109]). Optional elements were discretionary (e.g., the element intelligibility/communicative effectiveness was coded as optional in the Nonlinear approach given the statement, “Other goals of treatment may include general communicative effectiveness ...” [Bernhardt, Bopp, Daudlin, Edwards, & Wastie, 2010, p. 324]). To be coded as absent indicated that an element was not included or not mentioned in an intervention approach (e.g., the element imitation was coded absent in the NISI approach given the statement, “imitative prompting and drill activities are not key components for this approach” [Camarata, 2010, p. 396]).

Initially, all the researchers discussed the coding for the intervention approaches and reached consensus on definitions and interpretation. Next, the first two researchers read the chapter authors’ descriptions of each of the 15 intervention approaches, then coded all elements as required, optional, or absent. In Phase 2, the chapter text used as data was expanded to include text from additional chapter sections (viz., sections labeled *Materials and Equipment Required*, *Assessment and Progress Monitoring*, and *Case Study*; see Appendix A for a description). Coding of this additional text by the two researchers was completed by consensus for each element for each approach (1,095 element judgments).

Reliability

Once consensus had been reached for all elements, the first two researchers recoded two of the approaches independently to establish reliability, yielding 96.2% agreement for 130 data points. This level of reliability is consistent with that reported in Dunst et al. (2011), which used a similar methodology and coding system.

Results

The results are presented in two sections. First, we report on the frequency with which different intervention elements were coded as required, optional, or absent within and across the 15 intervention approaches studied. Second, we compare intervention approaches based on how many elements were coded for each approach (concentration), the percentage of optional elements to all elements comprising an approach (flexibility), and the percentage of rare elements and omitted common elements to all elements comprising an approach (distinctiveness).

Overview of Elements Across Approaches

The frequency with which elements were used across all interventions is presented in Table 2. The elements are listed in accordance with the domain, category, and subcategory structures of the Phonological Intervention Taxonomy.

Figure 1. Phonological Intervention Taxonomy. The figure presented in this clinical focus article appears courtesy of the authors. Copyright © 2017 by Elise Baker, A. Lynn Williams, Sharynne McLeod, and Rebecca J. McCauley.

PHONOLOGICAL INTERVENTION TAXONOMY			
GOAL	TEACHING MOMENT	CONTEXT	PROCEDURAL ISSUES
AREA OF FOCUS	ANTECEDENT EVENT	AGENT	INTENSITY
Sound segment production	<i>Content of model or instruction</i>	Speech-language pathologist	Session frequency
Phonological processes, rules, patterns, features, classes	Articulatory-phonetic	Parent	Session duration
Phonotactics (e.g., stress, word shapes)	Phonological	Teacher	Dose per session
Intelligibility / communicative effectiveness	Metaphor	Other children	Total intervention duration
Input processing / speech perception	Phonological awareness / literacy	Other agents	TRAINING
Phonological awareness / literacy	Semantic / morphologic / syntactic	VENUE	Speech-language pathologist (SLP) training
Other linguistic abilities (e.g., morphosyntax)	<i>Modality of model or instruction</i>	Clinic	Non-SLP training
CHARACTERISTICS OF TARGET / GOAL	Spoken	Home	EVALUATION
Stimulable sounds	Visual	School	Criterion-based progression
Non-stimulable sounds	Tactile / kinesthetic	SESSION FORMAT	Prescribed data collection
Early developing sounds	Gestural	Individual	
Later developing sounds	RESPONSE	Group	
Sounds always incorrect	<i>Level</i>	RESOURCES	
Sounds sometimes correct	Imitation	Paper-based	
Lexical inconsistency	Spontaneous	Objects	
Broader factors	<i>Requirement</i>	Scripts	
LINGUISTIC CONTEXT OF STIMULUS	Phonetic production	Computer / technology	
Isolated speech sounds / articulatory movements	Phonological production	ACTIVITIES	
Nonwords	Phonological awareness / literacy related	<i>Type</i>	
Real words	Non-speech	Naturalistic	
Sentences	Auditory / listening	Structured	
Conversation	Gestural	<i>Social / emotional valence</i>	
Contrastive words	CONSEQUENT EVENT	Challenging	
Written letters, words, or sentences	<i>Evaluative feedback</i>	Fun	
GOAL PROGRESSION STRATEGY	Knowledge of results		
Vertical	Knowledge of performance		
Horizontal	<i>Reflective feedback</i>		
Cyclical	Self-monitoring		
	<i>Responsive feedback</i>		
	Recast / expansion		

Legend

Domains

CATEGORIES

Subcategories

Elements

Table 2. Element use within the Phonological Intervention Taxonomy for 15 interventions.

Domain	Category	Subcategory	Elements	Required (score = 2) (bold = rare elements ^a)	Optional (score = 1)	Absent (score = 0) (bold = common elements omitted ^b)				
Goal	Focus		1. Sound segment production	10 (67%)	2 (13%)	3 (20%)				
			2. Phonological processes/rules/patterns/features/classes	6 (40%)	1 (7%)	8 (53%)				
			3. Phonotactics (e.g., stress, word shape)	3 (20%)	9 (60%)	3 (20%)				
			4. Intelligibility/communicative effectiveness	4 (27%)	6 (40%)	5 (33%)				
			5. Input processing/speech perception	2 (13%)	1 (7%)	12 (80%)				
			6. Phonological awareness and literacy	3 (20%)	3 (20%)	9 (60%)				
			7. Other linguistic abilities (e.g., morphosyntax)	4 (27%)	0 (0%)	11 (73%)				
	Characteristics of goal/target			8. Stimulable sounds	3 (20%)	6 (40%)	6 (40%)			
				9. Nonstimulable sounds	2 (13%)	7 (47%)	6 (40%)			
				10. Early developing sounds	2 (13%)	7 (47%)	6 (40%)			
				11. Later developing sounds	2 (13%)	8 (53%)	5 (33%)			
				12. Sounds always incorrect	2 (13%)	8 (53%)	5 (33%)			
				13. Sounds sometimes correct	1 (7%)	8 (53%)	6 (40%)			
				14. Lexical inconsistency	1 (7%)	1 (7%)	13 (87%)			
				15. Broader factors beyond sound segment	11 (73%)	4 (27%)	0 (0%)			
	Linguistic context of stimulus			16. Isolated speech sounds/articulatory movements	2 (13%)	10 (67%)	3 (20%)			
				17. Nonwords	2 (13%)	1 (7%)	12 (80%)			
				18. Real words	13 (87%)	1 (7%)	1 (7%)			
				19. Sentences	4 (27%)	8 (53%)	3 (20%)			
				20. Conversation	3 (20%)	7 (47%)	5 (33%)			
				21. Contrastive words	5 (33%)	2 (13%)	8 (53%)			
				22. Written letters, words, or sentences	4 (27%)	4 (27%)	7 (47%)			
				Goal progression strategy			23. Vertical	0 (7%)	8 (53%)	7 (47%)
							24. Horizontal	3 (20%)	8 (53%)	4 (27%)
							25. Cyclical	3 (20%)	5 (33%)	7 (47%)
Teaching moment	Antecedent event (clinician)	Content of model or instruction	26. Articulatory–phonetic	11 (73%)	1 (7%)	3 (20%)				
			27. Phonological	14 (93%)	1 (7%)	0 (0%)				
			28. Metaphor	1 (7%)	3 (20%)	11 (73%)				
			29. Phonological awareness/literacy	5 (33%)	4 (27%)	6 (40%)				
			3 (20%)	1 (7%)	11 (73%)					

(table continues)

Table 2. (Continued).

Domain	Category	Subcategory	Elements	Required (score = 2) (bold = rare elements ^a)	Optional (score = 1)	Absent (score = 0) (bold = common elements omitted ^b)
			30. Semantic/morphologic/ syntactic			
		Modality of model or instruction	31. Spoken	14 (93%)	1 (7%)	0 (0%)
			32. Visual	15 (100%)	0 (0%)	0 (0%)
			33. Tactile/kinesthetic	0 (0%)	5 (33%)	10 (67%)
			34. Gestural	1 (7%)	3 (20%)	11 (73%)
	Response (child)	Response level	35. Imitation	10 (67%)	3 (20%)	2 (13%)
			36. Spontaneous	13 (87%)	1 (7%)	1 (7%)
		Response requirement	37. Verbal: Phonetic production (speech sound/s)	3 (20%)	9 (60%)	3 (20%)
			38. Verbal: Phonological production (words +)	13 (87%)	1 (7%)	1 (7%)
			39. Phonological awareness/literacy related	5 (33%)	4 (27%)	6 (40%)
			40. Nonspeech: Prearticulatory/mouth movement	0 (0%)	2 (13%)	13 (87%)
			41. Auditory/listening	8 (53%)	1 (7%)	6 (40%)
			42. Gestural	1 (7%)	1 (7%)	13 (87%)
	Consequent event (clinician)	Evaluative feedback	43. Knowledge of results (e.g., judgment of correct/incorrect)	12 (80%)	2 (13%)	1 (7%)
			44. Knowledge of performance (e.g., shaping)	11 (73%)	3 (20%)	1 (7%)
		Reflective feedback	45. Request for the child's self-judgment/self-monitoring	6 (40%)	0 (0%)	9 (60%)
		Responsive feedback	46. Recast/expansion	6 (40%)	1 (7%)	8 (53%)
Context	Intervention agent		47. Speech-language pathologist (SLP)	15 (100%)	0 (0%)	0 (0%)
			48. Parent	7 (47%)	8 (53%)	0 (0%)
			49. Teacher	1 (7%)	9 (60%)	5 (33%)
			50. Other children	0 (0%)	4 (27%)	11 (73%)
			51. Other agents	0 (0%)	7 (47%)	8 (53%)
	Venue		52. Clinic	15 (100%)	0 (0%)	0 (0%)
			53. Home	6 (40%)	8 (53%)	1 (7%)
			54. School	1 (7%)	9 (60%)	5 (33%)
	Session format		55. Individual	9 (60%)	6 (40%)	0 (0%)
			56. Group	1 (7%)	6 (40%)	8 (53%)
	Resources		57. Paper based (e.g., books, cards)	12 (80%)	1 (7%)	2 (13%)
			58. Objects	9 (60%)	2 (13%)	4 (27%)
			59. Scripts	2 (13%)	0 (0%)	13 (87%)
			60. Computer/technology	2 (13%)	5 (33%)	8 (53%)
	Activities	Type	61. Naturalistic activities	5 (33%)	4 (27%)	6 (40%)
			62. Structured activities	11 (73%)	2 (13%)	2 (13%)
		Social/emotional valence	63. Challenging	2 (13%)	5 (33%)	8 (53%)
			64. Fun	4 (27%)	7 (47%)	4 (27%)

(table continues)

Table 2. (Continued).

Domain	Category	Subcategory	Elements	Required (score = 2) (bold = rare elements ^a)	Optional (score = 1)	Absent (score = 0) (bold = common elements omitted ^b)
Procedural issues	Intensity		65. Session frequency	6 (40%)	9 (60%)	0 (0%)
			66. Session duration	7 (47%)	8 (53%)	0 (0%)
			67. Dose per session	0 (0%)	3 (20%)	12 (80%)
	Training		68. Total intervention duration	2 (13%)	6 (40%)	7 (47%)
			69. SLP prerequisite knowledge/ specific training requirements	1 (7%)	0 (0%)	14 (93%)
			70. Non-SLP personnel prerequisite knowledge/specific training requirements	4 (27%)	5 (33%)	6 (40%)
	Evaluation		71. Criterion-based progression	3 (20%)	3 (20%)	9 (60%)
72. Prescribed data collection			5 (33%)	10 (67%)	0 (0%)	

^aRare elements (bolded cells in Column 5) were coded as required for three or fewer approaches (Column 5) and absent by more than 50% of approaches (Column 7). ^bCommon elements omitted (bolded cells in Column 7) were coded as absent for three or fewer approaches (Column 7) and required for more than 50% of approaches (Column 5).

Goal

Focus

Across the 15 approaches, goals could focus on up to seven different areas: (a) sound segments, (b) phonological processes/rules/patterns/rules/features/classes, (c) phonotactics, (d) intelligibility/communicative effectiveness, (e) input processing/speech perception, (f) phonological awareness/literacy, and (g) other linguistic abilities. The most common required goal focus was sound segments ($n = 10$), whereas input processing/speech perception was the least common goal focus ($n = 2$). Although no single approach incorporated all areas of focus, two approaches—the Cycles and Psycholinguistics approaches—were coded as addressing up to six areas.

Characteristics of Goal/Target

Eight target characteristics were examined as possible elements for each of the 15 phonological intervention approaches. Most of these characteristics centered on sound segments (stimulable sounds, nonstimulable sounds, early developing sounds, later developing sounds, sounds always incorrect, sounds sometimes correct). These characteristics were often coded as optional, suggesting that most approaches allow users considerable latitude or discretion in the characteristics of the speech segments targeted in intervention. Other target characteristics included lexical inconsistency and broader factors. This latter target characteristic captures factors beyond the sound segment, such as phonotactic structures, phoneme collapses, intelligibility, phonological awareness, and other linguistic domains—individual elements specified in the category goal focus.

Linguistic Context of Stimulus

Seven linguistic contexts were coded as possible elements: (a) isolated speech sounds or articulatory movements, (b) nonwords, (c) real words, (d) sentences, (e) conversation, (f) contrastive words, or (g) written letters/words/sentences. Of these, real words was the most frequently coded required context ($n = 13$), whereas nonwords and isolated speech sounds were the least frequently coded required contexts ($n = 2$). One approach (Psycholinguistics) was coded as requiring or optionally including all linguistic contexts. In contrast, only two approaches were coded as requiring only one linguistic context: The Speech Perception approach was coded as requiring the use of real words, and the NISI approach was coded as requiring the use of conversation.

Goal Progression Strategy

The three goal progression strategies identified as possible elements were horizontal, vertical, and cyclical. Three approaches (Cycles, Nonlinear, and Morphosyntax approaches) were coded as requiring a cyclical progression strategy and, three (Stimulability, Dynamic Systems, and enhanced milieu teaching with phonological emphasis [EMT/PE; Scherer & Kaiser, 2010]), as requiring a horizontal

strategy. For eight of the nine remaining intervention approaches, two or more goal progression strategies were identified and coded as optional (e.g., Complexity approach could use vertical or horizontal goal attack strategies). The remaining intervention approach, Core Vocabulary, was not assigned a goal progression strategy as the area of focus was lexical consistency.

Teaching Moment

Antecedent Event

Content of model or instruction. Of the five examined model contents (articulatory–phonetic, phonological, metaphor, phonological awareness and literacy, and semantic/morphologic/syntactic), a phonological model was most commonly coded as required ($n = 14$). Although other model contents occurred less frequently, such as metaphor ($n = 1$), it may be that this element was incorporated in more approaches but was not explicitly specified in the text. All five model contents were coded as required or optional in PACT, whereas only one model content (i.e., spoken phonological model of a word) was coded as required in the Speech Perception and NISI approaches.

Modality of model and/or instruction. Of the four modalities we examined as possible elements (spoken, tactile/kinesthetic, visual, gestural), spoken model was specified as required by 14 approaches and optional by the remaining approach (NISI). Two approaches (Stimulability, Psycholinguistics) specified use of all four modalities as either required or optional.

Response

Response level. Two response levels were identified. Spontaneous response was the most commonly coded response level ($n = 13$), followed by imitation ($n = 10$). Ten of the 15 approaches indicated that both spontaneous and imitative response levels were to be used.

Response requirement. Six response requirements were identified. Verbal production of words was the most commonly required response from the child ($n = 13$), whereas a nonspeech prearticulatory mouth movement was coded absent for 13 approaches. Across approaches, Cycles and PACT incorporated five of the six types of child responses as required or optional, whereas the Speech Perception approach and NISI only specified one type of response from the child (viz., auditory/listening and verbal productions, respectively).

Consequent Event

Evaluative feedback. Both types of evaluative feedback, knowledge of results and knowledge of performance, were frequently coded as required ($n = 12$ and 11, respectively). Two approaches (Stimulability, EMT/PE) indicated optional use of both knowledge of results and knowledge of performance, and only one approach (NISI) was coded as not requiring either type of evaluative feedback.

Reflective feedback. Request for repair or self-judgment was coded as required for six approaches and as not specified

as a consequent event in the remaining nine interventions. The six approaches that were coded as requiring use of reflective feedback were Minimal Pairs, Multiple Oppositions, Core Vocabulary, Psycholinguistics, Metaphonology, and PACT.

Responsive feedback. Six interventions were coded as requiring responsive feedback (Multiple Oppositions, Stimulability, Dynamic Systems, Morphosyntax, NISI, and EMT/PE). Of the remaining nine interventions, eight did not require responsive feedback, and the PACT approach indicated that use of responsive feedback was optional.

Context

Intervention Agent

Of the five different intervention agents that could be included in an intervention (SLP, parent, teacher, other children, other agents), SLP was coded as required across all approaches ($n = 15$), with parent required for seven approaches. Teachers were coded as required for one approach (Core Vocabulary). If they were not coded as required intervention agents, parents and teachers were typically coded as optional elements. Overall, although most approaches incorporated at least two different intervention agents, two approaches (Nonlinear and NISI) required or indicated optional use of all five possible intervention agents.

Venue

Of the three possible venues (clinic, home, school), clinic was coded as required for all approaches ($n = 15$), whereas school was coded as the least specified venue ($n = 1$; Core Vocabulary). Across approaches, all three venues were coded as required or optional for most ($n = 11$) approaches. Conversely, one approach (Speech Perception) required just one venue (i.e., clinic). This appeared to reflect the goal types specified by the approaches.

Session Format

Of the two session formats (individual, group), individual therapy sessions were coded as required for eight approaches, individual and group were coded as required for one approach (Morphosyntax), and individual and/or group was coded as optional for the remaining six approaches (Minimal Pairs, Multiple Oppositions, Psycholinguistics, Metaphonology, Nonlinear, and Dynamic Systems).

Resources

Of the four types of resources we identified (paper-based, objects, scripts, computer/technology), paper-based resources, such as cards or books, was the most common element coded as required ($n = 12$), whereas scripts and computer/technology were coded as the least common required resource ($n = 2$ for each). Across approaches, no approach utilized all four types of resources. The Speech Perception approach was coded as requiring only a single resource (i.e., computer/technology).

Activities

Type. Of the two types of activities we examined, structured activities were coded as required ($n = 11$) more than naturalistic activities ($n = 5$). Both activity types were coded as required in two approaches (Multiple Oppositions, PACT). Two approaches did not include structured activities, rather requiring naturalistic activities only (NISI and EMT/PE).

Social/emotional valence. Fun activities were coded as required for four approaches (PACT, Morphosyntax, Nonlinear, Stimulability) and challenging for two approaches (Minimal Pairs, Complexity). Four approaches (Psycholinguistics, Metaphonology, Speech Perception, and EMT/PE) specified both elements as optional. It is possible this one or both elements were assumed and, thus, not included in authors' descriptions, given that information about intervention activities being challenging or fun was absent for eight and four approaches, respectively.

Procedural Issues

Intensity

The four elements related to intensity were duration, frequency, dose, and total intervention duration. All approaches were coded as either required or optional for duration and frequency. Although never coded as required, *dose* was sometimes coded as an optional element ($n = 3$; Multiple Oppositions, Core Vocabulary, and Morphosyntax). It was unclear whether the absence of information about dose for the majority of approaches ($n = 12$) was indicative that a predetermined dose was not required or that information about dose was unspecified in the chapters.

Training

Intervention approaches only rarely specified that training was required for either *SLPs* ($n = 1$) or for non-SLP personnel ($n = 4$). In fact, six approaches (Minimal Pairs, Multiple Oppositions, Complexity, Cycles, Stimulability, and Nonlinear) made no mention of training. Five approaches (Core Vocabulary, Speech Perception, Dynamic Systems, Morphosyntax, and NISI) coded training as optional for non-SLP personnel, and only one approach (EMT/PE) required special training for SLP and non-SLP personnel.

Evaluation

Criterion-based progression was coded as required for three approaches (Minimal Pairs, Multiple Oppositions, and Complexity) and optional for an additional three approaches (Core Vocabulary, Nonlinear, Morphosyntax). By contrast, all approaches were coded as required or optional for prescribed data collection.

To summarize, 16 of the 72 elements were coded as required for 10 or more of the approaches. Common elements included goals related to sound segments with *SLPs* providing visual and spoken phonological models and requiring spontaneous production of words. Feedback was

primarily evaluative (knowledge of results and knowledge of performance), rather than responsive or reflective. Intervention was delivered by SLPs in the clinic in structured individual sessions using paper-based resources. Conversely, the goal elements that were rarely coded as required included input processing, phonological awareness/literacy, and lexical inconsistency. Other elements rarely coded as required included isolated speech sounds/articulatory movements and nonwords as the stimulus context, the use of metaphor and semantic/morphological/syntactic in models, using tactile/kinesthetic and/or gestural mode for providing models, nonspeech prearticulatory mouth movements in children's responses, intervention agents involving other non-SLP personnel, school venue, group format, scripts or computer/technology resources, and naturalistic activities. Several subcategories were coded as required or optional less frequently across approaches, which may be an artifact of the detail included within the text by each author. These areas included type of activities (naturalistic, structural), intensity, social/emotional valence, training, and evaluation.

Overview of Approaches With Respect to Concentration, Flexibility, and Distinctiveness

The three constructs of concentration, flexibility, and distinctiveness were created to characterize individual approaches with respect to the numbers of elements specified as required or optional (concentration), the percentage of optional elements relative to the total elements comprising an approach (flexibility), and the percentage with which rare elements are included and common elements are omitted relative to the total elements comprising an approach (distinctiveness). Together, these three measures were used to consider the similarities and differences across approaches.

Concentration

The total number of elements coded as required or optional per approach, defined as *concentration*, is shown in Table 1. Recall that a total of 72 elements were identified in the development of the Phonological Interventional Taxonomy. The mean concentration of elements across approaches was 45 elements, with 25 coded as required. As listed in Table 1, the densest approaches (i.e., the approaches with the largest number of elements coded as required or optional) were Psycholinguistics and PACT, each with 59 of 72 elements (82%). Of these two approaches, PACT had the highest number of required elements at 36. The least dense approach was Speech Perception intervention with 27 of 72 possible elements (37.5%), 13 of which were coded as required. Although Speech Perception was coded as having the smallest number of required elements, it is important to note that this approach is always complemented with an approach targeting speech production (Rvachew & Brosseau-Lapr e, 2010) that would comprise its own set of elements. Similarly, the Morphosyntax approach, comprising 42 elements, alternates with an approach targeting speech production (Tyler & Haskill, 2010). NISI, which

focuses on intelligibility, may also be complemented with Naturalistic Intervention for Speech Accuracy (Camarata, 2010).

Flexibility

Flexibility was defined as the proportion of elements rated as optional relative to the total number of elements (ratings as optional or required) per approach. The mean flexibility across all 15 approaches was 44%, and the flexibility score for each approach is in Table 1. Minimal Pairs had a total of 48 elements, of which 26 were rated as optional, yielding a flexibility score of 54%. This meant that approximately half of the elements described in the Minimal Pairs approach could be used at the clinicians' discretion. The Nonlinear and Psycholinguistics approaches were the most flexible, with flexibility scores of 62% and 58%, respectively. Approaches with a lower proportion of elements coded as optional included the Dynamic Systems (29%) and Cycles approaches (32%).

Distinctiveness

To clarify what made the approaches different from one another, we constructed a measure of *distinctiveness* by examining how frequently rare elements were included and common elements were omitted. Specifically, *rare elements* were defined as required for three or fewer approaches but absent for more than 50% of approaches; *common elements* were defined as absent for three or fewer approaches but required for more than 50% of approaches. Then, distinctiveness was calculated as the following percentage: $(\# \text{ of rare elements} + \# \text{ of omitted common elements}) / [\text{all elements included in the intervention}] \times 100$. This process led to the identification of 14 rare elements and 10 common elements omitted. Rare elements were dispersed across 11 of the 15 categories in the taxonomy and are shown in Table 2. The majority of approaches ($n = 14$) had up to three rare elements (average number of rare elements 1.7). By contrast, common elements were omitted in fewer approaches ($n = 4$). When distinctiveness was calculated, Speech Perception was considered the most distinctive approach with 30% of elements being distinct, followed by NISI with 23% of elements being distinct. The majority of approaches typically had one or two rare elements (6% of elements overall) distinguishing them from most other approaches.

Discussion

Clinicians working with children with SSD have many choices about which intervention approach to use. As the results from our investigation have shown, phonological intervention approaches vary in their combination of elements with respect to total number of elements (i.e., concentration), proportion of optional elements (i.e., flexibility), and proportion of included rare and omitted common elements versus the total number of elements (i.e., distinctiveness). Some approaches have more elements or are more concentrated than others. Most also contain rare elements uncommon to most approaches. In this discussion, we reflect

on the findings from the development of the Phonological Intervention Taxonomy and the description of 15 intervention approaches using the taxonomy. We discuss the implications of the findings from this qualitative investigation with respect to intervention research, teaching, and implementation. We also consider the limitations of our efforts and posit directions for future research.

Reflections on the Phonological Intervention Taxonomy and Intervention Elements

We began this process of better understanding the diversity of phonological interventions for children with SSD, proposing that one view of intervention approaches is as a bundle of elements designed for use as a collective package—a theoretical view similar to that reflected in the treatment theory that guided the development of the RTT (Turkstra et al., 2016). Empirical support for interventions is also grounded in the additive, synergistic, and antagonistic effect of the package, not the individual elements. That is, the overall effect of intervention is not always as simple as the sum of the elements (additive). The effect can be greater than the sum of the elements, as elements support one another (synergistic). It could also be less than the sum of the elements, as elements counteract one another (antagonistic). An appreciation for the diversity of choice of approaches, however, necessitates a reductionist rather than a holistic approach to understanding the elements comprising interventions. In this study, we used authors' (usually the developers') descriptions of 15 empirically supported interventions to identify and describe elements of intervention *a posteriori*. Using content analysis, we identified 72 elements and arranged them into a hierarchical framework comprising four broad domains and 15 categories and nine subcategories. We described each of the 15 interventions with respect to the required or optional inclusion or absence of each element.

In the introduction to this clinical focus article, we speculated about the degree to which the many approaches to intervention differ. The finding that, on average, the interventions were coded as containing 45 elements, with the majority of approaches containing three or fewer rare elements, suggests that there are similarities. It remains to be determined whether some elements are common because they are essential, reminiscent of traditional practice, or are playing an, as yet, unidentified role. In the general concept of treatment theories incorporated in the RTT described by Turkstra et al. (2016), two types of active ingredients are postulated: those that are essential to the treatment theory being instantiated and those that are simply present in the intervention. Applying this to the Phonological Intervention Taxonomy, developers of approaches might explicate their intervention by identifying essential (active) elements crucial to improving children's speech intelligibility (e.g., specific target characteristics) while acknowledging the presence of other active elements (e.g., social/emotional valence, evaluative feedback) in conjunction with the theoretical perspectives motivating those elements.

A good starting point may be to better understand how the presence of one or more rare elements within a bundle of common elements or, indeed, the absence of a common element in an approach distinguishes one approach from another, not just in terms of procedures but also in terms of their efficacy. Developers' different realization of similarly coded elements also requires consideration. The element of an "auditory/listening" response requirement is a good example. For instance, the listening tasks included in the Speech Perception approach (Rvachew & Brosseau-Lapr e, 2010) are not the same as the listening tasks used in the Psycholinguistics approach (Stackhouse & Pascoe, 2010), which, again, are not the same as those used in the Cycles approach (Prezas & Hodson, 2010). In our taxonomy, their respective listening tasks were all coded under the same element classification (*domain*: teaching moment; *category*: child's response; *subcategory*: response requirement, *element*: auditory/listening). This point highlights the descriptive nature of the Phonological Intervention Taxonomy. It is not meant to serve as a rigid framework limiting our understanding of what constitutes interventions but a platform for facilitating discussion and richer understandings about the elements that make up interventions, how interventions compare, and, especially, how those elements impact the performance of the intervention.

Implications for Intervention Research

In this study, intervention elements were identified *a posteriori*. The resulting Phonological Intervention Taxonomy revealed that many elements can make up interventions. The coding process also suggested that some elements needed to be more explicitly specified in their developer's descriptions. For instance, across the 15 approaches, 12 did not provide sufficient information about dose per session (an aspect of the *intensity* category). However, in reality, the rarity of this element may in fact be an artifact of either insufficient empirical knowledge related to this element or the unlikely idea that a prescribed dose per session is not crucial (E. Baker, 2012) and, therefore, not currently a required or even optional element. Such results highlight the importance of clarity in intervention descriptions (including what elements are required, optional, or intentionally absent), given that descriptions are an important medium for knowledge translation and replication. One way forward to further clarifying what is known about individual interventions could be to interview developers about the ideas and elements underscoring their approaches, compile the empirical evidence, and observe developers demonstrating their approach. In this way, a rich compendium of *a priori* and *a posteriori* knowledge from multiple sources could advance clinical practice.

Assuming that the elements of the intervention are known and explicit, it would be important that research determine the necessity, timing, and individual, synergistic, or possible antagonistic effect of elements comprising interventions. Such research would help to distill the active elements of an intervention, improving both effectiveness and

efficiency. Future research could also consider when and how elements (particularly optional elements) are to be used and how they might be tailored to meet the needs of individual children. For instance, Major and Bernhardt (1998) identified that client characteristics influenced the necessity of phonological awareness activities in intervention. Similarly, Rvachew and Brosseau-Lapr e (2010) have reported that many, but not all, children benefit from speech perception training prior to intervention focused on production practice. Another valuable line of inquiry would be to examine practicing clinicians' implementation of interventions, including the interventions considered in the current investigation, other empirically supported approaches, and clinicians' own eclectic practice (e.g., Lancaster, Keusch, Levin, Pring, & Martin, 2010) to explore if, when, and how clinicians tailor interventions to individual children. The better we understand the elements that comprise interventions and the effect of those elements, the better clinicians will be able to select, tailor, and implement interventions to optimize outcomes for children.

Given that phonological impairment is one type of SSD, future research could apply the *a posteriori* method from this study to other types of interventions, particularly interventions for motor speech disorders, such as childhood apraxia of speech and childhood dysarthria. In this way, richer insight into the similarities and differences between phonological and motor-based interventions could advance our understanding about important required versus optional and absent elements across interventions for different types of SSD. Given that the majority of phonological interventions include speech production practice and that there is an inextricable nexus between phonology and motor speech abilities (Fey, 1985), this research could help clarify the role of the principles of motor learning and ensuing elements, such as the optimal conditions of practice (e.g., amount, distribution, schedule) and feedback (e.g., frequency, type, timing; Maas et al., 2008) in phonological interventions.

Implications for Teaching and Implementation

One of the chief intents of the Phonological Intervention Taxonomy was to increase the transparency of intervention descriptions for children with SSD, as a means of improving clinical training and implementation. The fact that the intervention approaches differed with respect to element concentration, flexibility, and distinctiveness raises questions about how approaches can best be taught. Given that approaches contain a combination of common and rarer elements, it may be helpful for students to become familiar with common elements advancing to rare elements, as they build their knowledge and expertise about individual approaches. Potentially, this could also foster an understanding about similarities and differences between approaches. Similarly, given that some approaches contain more elements than others, it may be beneficial for students to learn about approaches containing fewer elements, before learning about denser interventions containing multiple

elements. Interventions that are denser and/or contain more rare elements may require more explicit instruction and demonstration for SLPs to develop expertise in a particular intervention. The Phonological Intervention Taxonomy, therefore, facilitates hypotheses that might guide future studies supporting clinical training.

In light of the diversity across interventions, studying the demands on SLPs to faithfully implement different approaches might fruitfully be examined with respect to the concentration, flexibility, and distinctiveness of elements or even the identity of individual elements, some of which may pose lower demands than others. It may be that faithful implementation of approaches with more elements, greater flexibility of elements, and/or more unique elements requires more experience, greater manualization, or other supports for implementation. The multitasking inherent during intervention sessions suggests that frequent and repetitive implementation of specific elements (i.e., experience) may reduce the task demand enabling faithful implementation. SLPs may also use a particular approach over another simply because it is easier and more enjoyable to implement. As yet, we know little about what is required to faithfully implement the diverse range of phonological interventions (Justice, 2010). Research examining expert and novice clinicians may provide insight into the resources, skills, and attitudes required for successful knowledge transfer and implementation.

Given that eclectic practice is used by some SLPs (Brumbaugh & Smit, 2013; McLeod & Baker, 2014), research examining the elements that comprise eclectic practice may better inform an understanding not only of the efficacy of such practice but also of the motivations underlying departures from faithful implementation of empirically supported interventions. Do SLPs engage in eclectic practice because the elements that comprise specific empirically supported approaches have not been made sufficiently explicit or because the methods comprising these approaches have not been disseminated or taught to SLPs in a manner that they can faithfully implement? Perhaps, novice SLPs engage in eclectic practice as they learn to implement and become more familiar with the multiple elements that comprise an approach. Conversely, perhaps expert SLPs engage in eclectic practice by using their clinical expertise to modify elements known to be part of an approach and/or implement optional elements according to client need. Departures from fidelity may have much to teach us about the cognitive demands associated with intervention delivery.

Limitations

The methods we used to describe interventions then examine them with respect to concentration, flexibility, and distinctiveness are not without limitations. The process was complex and required a level of inference on the part of the coders. The data for the content analysis and review used chapter authors' descriptions of interventions within Williams et al. (2010). Although a second source was used

to ensure that saturation of elements had been achieved, future research could address the match between the Phonological Intervention Taxonomy and the wider body of literature on each approach (e.g., books, clinical resources, published research, and video examples of implementation). In particular, information is needed that bridges the distance between the ways in which interventions are methodically described and the ways in which they are actually implemented, both in research and clinical settings.

In addition, this review was based on 15 phonological intervention approaches, whereas E. Baker and McLeod (2011) identified 46 distinct phonological intervention approaches with 23 described in more than one publication. The approaches that were selected for the current review had empirical evidence and were all described by the authors using the same template (see Appendix A). It is acknowledged, however, that other approaches may include additional elements. Furthermore, interventions that target motor speech difficulties were not included in the current review. Selected principles of motor learning (e.g., high vs. low frequency feedback) were not identified within the 15 phonological interventions, so this descriptor of clinician feedback was not included in the Phonological Intervention Taxonomy. As noted, subsequent research could address the match between this framework and the other phonological and motor speech approaches.

Finally, this taxonomy now sits within the field of speech-language pathology at a time when taxonomies are being developed in other areas (e.g., Turkstra et al., 2016; Van Stan et al., 2015), yet to date, no coordination of development efforts has been pursued. It is likely that the largely behavioral interventions used in voice, rehabilitation, SSD in children, and other areas of intervention in speech-language pathology have much in common with each other and that the promotion of coordinated efforts might limit an unhelpful burgeoning of alternative terminologies—a concern noted by Van Stan et al. (2015) in their incorporation of a dictionary/thesaurus in their taxonomy. On a wider scale, still, the proliferation of taxonomies across many related fields (e.g., behavioral health, rehabilitation, education) suggests the value of even broader interdisciplinary efforts.

Conclusion

This study demonstrated the importance of thinking about intervention approaches both as a whole and in terms of the individual elements comprising them. The Phonological Intervention Taxonomy represents a step in describing the elements within and across phonological interventions. Further research is needed to clarify all elements that comprise individual approaches, distil the active elements, and identify strategies that best facilitate faithful replication and implementation to enhance SLPs' selection of intervention approaches and implementation in accordance with developers' intentions.

Acknowledgment

The first and third authors acknowledge support from an Australian Research Council Discovery Grant DP130102545.

References

- * = Chapters reporting phonological intervention approaches that were included in the study.
- Abraham, C., & Michie, S.** (2008). A taxonomy of behavior change techniques used in interventions. *Health Psychology, 27*(3), 379–387.
- Abry, T., Hulleman, C. S., & Rimm-Kaufman, S. E.** (2015). Using indices of fidelity to intervention core components to identify program active ingredients. *American Journal of Evaluation, 36*(3), 320–338.
- American Psychological Association.** (2010). *Publication manual of the American Psychological Association* (6th ed.). Washington, DC: Author.
- Andrews, G., Guitar, B., & Howie, P.** (1980). Meta-analysis of the effects of stuttering treatment. *Journal of Speech and Hearing Disorders, 45*, 287–307.
- ***Baker, E.** (2010). Minimal pair intervention. In A. L. Williams, S. McLeod, & R. J. McCauley (Eds.), *Interventions for speech sound disorders in children* (pp. 41–72). Baltimore, MD: Brookes.
- Baker, E.** (2012). Optimal intervention intensity. *International Journal of Speech-Language Pathology, 14*(5), 401–409.
- Baker, E., & McLeod, S.** (2011). Evidence-based practice for children with speech sound disorders: Part 1 narrative review. *Language, Speech, and Hearing Service in Schools, 42*(2), 102–139.
- ***Baker, E., & Williams, A. L.** (2010). Complexity approaches to intervention. In A. L. Williams, S. McLeod, & R. J. McCauley (Eds.), *Interventions for speech sound disorders in children* (pp. 95–116). Baltimore, MD: Brookes.
- Baker, M.** (2015). First results from psychology's largest reproducibility test. *Nature*. Retrieved from <https://doi.org/10.1038/nature.2015.17433>
- ***Bernhardt, B. M., Bopp, K. D., Daudlin, B., Edwards, S. M., & Wastie, S. E.** (2010). Nonlinear phonological intervention. In A. L. Williams, S. McLeod, & R. J. McCauley (Eds.), *Interventions for speech sound disorders in children* (pp. 315–332). Baltimore, MD: Brookes.
- ***Bowen, C.** (2010). Parents and Children Together (PACT) intervention. In A. L. Williams, S. McLeod, & R. J. McCauley (Eds.), *Interventions for speech sound disorders in children* (pp. 407–426). Baltimore, MD: Brookes.
- Brumbaugh, K. M., & Smit, A. B.** (2013). Treatment children ages 3–6 who have speech sound disorder: A survey. *Language, Speech, and Hearing Services in Schools, 44*, 306–319.
- Camarata, S. M.** (1995). A rationale for naturalistic speech intelligibility intervention. In M. E. Fey, J. Windsor, & S. F. Warren (Eds.), *Language intervention: Preschool through elementary years* (Communication and language intervention series, Vol. 5, pp. 63–84). Baltimore, MD: Brookes.
- ***Camarata, S.** (2010). Naturalistic intervention for speech intelligibility and speech accuracy. In A. L. Williams, S. McLeod, & R. J. McCauley (Eds.), *Interventions for speech sound disorders in children* (pp. 381–406). Baltimore, MD: Brookes.
- Des Jarlais, D. C., Lyle, C., Crepaz, N., & the TREND Group.** (2004). Improving the reporting quality of nonrandomized evaluations of behavioral and public health interventions: The

- TREND Statement. *American Journal of Public Health*, 94, 361–366.
- Dijkers, M. P.** (2015). Reporting on interventions: Issues and guidelines for rehabilitation researchers. *Archives of Physical Medicine and Rehabilitation*, 96(6), 1170–1180.
- Dijkers, M. P., Hart, T., Whyte, J., Zanca, J. M., Packel, A., & Tsaousides, T.** (2014). Rehabilitation treatment taxonomy: Implications and continuations. *Archives of Physical Medicine and Rehabilitation*, 95(Supplement), S45–S54.
- Dingfelder, H. E., & Mandell, D. S.** (2011). Bridging the research-to-practice gap in autism intervention: An application of diffusion of innovation theory. *Journal of Autism and Developmental Disorders*, 41, 597–609.
- *Dodd, B., Holm, A., Crosbie, S., & McIntosh, B.** (2010). Core vocabulary intervention. In A. L. Williams, S. McLeod, & R. J. McCauley (Eds.), *Interventions for speech sound disorders in children* (pp. 117–136). Baltimore, MD: Brookes.
- Dunst, C. J., Raab, M., & Trivette, C. M.** (2011). Characteristics of naturalistic language intervention strategies. *Journal of Speech-Language Pathology and Applied Behavior Analysis*, 11(5), 8–16.
- Eifert, G., Schulte, D., Zvolensky, M. J., Lejuez, C. W., & Lau, A. W.** (1997). Manualized behavior therapy: Merits and challenges of manualized behavior therapy: The debate. *Behavior Therapy*, 28, 499–509.
- Emby, D. D., & Biglan, A.** (2008). Evidence-based kernels: Fundamental units of behavioral influence. *Clinical Child and Family Psychology Review*, 11, 75–113.
- Fey, M. E.** (1985). Articulation and phonology: Inextricable constructs in speech pathology. *Human Communication Canada*, 9(1), 7–16.
- Fey, M. E., & Finestack, L. H.** (2009). Research and development in child language intervention: A five-phase model. In R. G. Schwartz (Ed.), *Handbook of child language disorders* (pp. 513–531). New York, NY: Psychology Press.
- Guitar, B. E., & McCauley, R. J.** (2010). *Treatment of stuttering: Established and emerging interventions*. Baltimore, MD: Wolters-Kluwer Publishers.
- Hammer, C. S.** (2011). The importance of participant demographics. *American Journal of Speech-Language Pathology*, 20(4), 261.
- Hatch, J. A.** (2002). *Doing qualitative research in education settings*. Albany, NY: State University of New York.
- Hegde, M. N.** (1985). *Treatment procedures in communication disorders*. San Diego, CA: College-Hill Press.
- *Hesketh, A.** (2010). Metaphonological intervention: Phonological awareness. In A. L. Williams, S. McLeod, & R. J. McCauley (Eds.), *Interventions for speech sound disorders in children* (pp. 247–274). Baltimore, MD: Brookes.
- Hoffman, P. R., & Norris, J. A.** (2010). Dynamic systems and whole language intervention. In A. L. Williams, S. McLeod, & R. J. McCauley (Eds.), *Interventions for speech sound disorders in children* (pp. 333–354). Baltimore, MD: Brookes.
- Hoffmann, T. C., Glasziou, P. P., Boutron, I., Milne, R., Perera, R., Moher, D., . . . Michie, S.** (2014). Better reporting of interventions: Template for Intervention Description and Replication (TIDieR) checklist and guide. *BMJ*, 348, g1687.
- Ioannidis, J. P. A.** (2005). Contradicted and initially stronger effects in highly cited clinical research. *Journal of the American Medical Association*, 294(2), 218–228.
- Justice, L. M.** (2010). When craft and science collide: Improving therapeutic practices through evidence-based innovations. *International Journal of Speech-Language Pathology*, 12(2), 79–86.
- Kaderavek, J. N., & Justice, L. M.** (2010). Fidelity: An essential component of evidence-based practice in speech-language pathology. *American Journal of Speech-Language Pathology*, 19(4), 369–379.
- Lancaster, G., Keusch, S., Levin, A., Pring, T., & Martin, S.** (2010). Treating children with phonological problems: Does an eclectic approach to therapy work? *International Journal of Language & Communication Disorders*, 45(2), 174–181.
- Lincoln, Y. S., & Guba, E. G.** (1985). *Naturalistic inquiry*. Thousand Oaks, CA: Sage.
- Ludemann, A., Power, E., & Hoffmann, T. C.** (2017). Investigating the adequacy of intervention descriptions in recent speech-language pathology literature: Is evidence from randomized trials useable? *American Journal of Speech-Language Pathology*, 26(2), 443–455.
- Maas, E., Robin, D. A., Austermann Hula, S. N., Freedman, S. E., Wulf, G., Ballard, K. J., & Schmidt, R. A.** (2008). Principles of motor learning in treatment of motor speech disorders *American Journal of Speech-Language Pathology*, 17(3), 277–298.
- Major, E. M., & Bernhardt, B. H.** (1998). Metaphonological skills of children with phonological disorders before and after phonological and metaphonological intervention. *International Journal of Language & Communication Disorders*, 33(4), 413–444.
- Makel, M. C., & Plucker, J. A.** (2014). Facts are more important than novelty: Replication in the educational sciences. *Educational Researcher*, 43(6), 304–316.
- Malouf, D. B., & Taymans, J. M.** (2016). Anatomy of an evidence base. *Educational Researcher*, 45, 454–459.
- McCartney, E., Boyle, J., Bannatyne, S., Jessiman, E., Campbell, C., Kelsey, C., . . . O'Hare, A.** (2004). Becoming a manual occupation? The construction of a therapy manual for use with language impaired children in mainstream primary schools. *International Journal of Language & Communication Disorders*, 39(1), 135–148.
- McCauley, R. J., & Demetras, M. J.** (1990). The identification of language impairment in the selection of specifically language impaired subjects. *Journal of Speech and Hearing Disorders*, 5, 468–475.
- McCauley, R. J., & Fey, M. E.** (2006). Introduction. In R. J. McCauley & M. E. Fey (Eds.), *Treatment of language disorders in children* (pp. 1–20). Baltimore, MD: Brookes.
- McCauley, R. J., Fey, M. E., & Gillam, R. B.** (2017). Introduction. In R. J. McCauley, M. E. Fey, & R. B. Gillam (Eds.), *Treatment of language disorders in children* (2nd ed., pp. 1–22). Baltimore, MD: Brookes.
- McIntyre, L. L., Gresham, F. M., DiGennaro, F. D., & Reed, D. D.** (2007). Treatment integrity of school-based interventions with children in the Journal of Applied Behavior Analysis 1991–2005. *Journal of Applied Behavior Analysis*, 40, 659–672.
- McLeod, S., & Baker, E.** (2014). Speech-language pathologists' practices regarding assessment, analysis, target selection, intervention, and service delivery for children with speech sound disorders. *Clinical Linguistics & Phonetics*, 28(7–8), 508–531.
- McLeod, S., & Baker, E.** (2017). *Children's speech: An evidence-based approach to assessment and intervention*. Boston, MA: Pearson.
- *Miccio, A. W., & Williams, A. L.** (2010). Stimulability intervention. In A. L. Williams, S. McLeod, & R. J. McCauley (Eds.), *Interventions for speech sound disorders in children* (pp. 179–202). Baltimore, MD: Brookes.
- Michie, S., Abraham, C., Eccles, M. P., Francis, J. J., Hardeman, W., & Johnson, M.** (2011). Strengthening evaluation and implementation by specifying components of behaviour change interventions: A study protocol. *Implementation Science*, 6, 10. <https://doi.org/10.1186/1748-5908-6-10>

- Michie, S., Fixsen, D., Grimshaw, J. M., & Eccles, M. P. (2009). Specifying and reporting complex behaviour change interventions: The need for a scientific method. *Implementation Science, 4*, 4–40.
- Moher, D., Schulz, K. R., Altman, D., & the CONSORT Group. (2001). The CONSORT Statement: Revised recommendations for improving the quality of reports of parallel-group randomized trials. *Journal of the American Medical Association, 185*(15), 1987–1991.
- Müller-Merbach, H. (2007). Kant's two paths of knowledge creation: *A priori* vs. *a posteriori*. *Knowledge Management Research and Practice, 5*(1), 64–65.
- Muma, J. R. (1993). The need for replication. *Journal of Speech and Hearing Research, 36*(5), 927–930.
- Open Science Collaboration. (2015). Estimating the reproducibility of psychological science. *Science, 349*(6251), aac4716. <https://doi.org/10.1126/science.aac4716>
- Plutchik, R. (1983). *Foundations of experimental research* (3rd ed.). New York, NY: Harper & Row.
- Prelock, P., & McCauley, R. J. (2012). *Treatment of autism spectrum disorders: Evidence-based intervention strategies for communication and social interventions*. Baltimore, MD: Brookes.
- *Prezas, R. F., & Hodson, B. W. (2010). The cycles phonological remediation approach. In A. L. Williams, S. McLeod, & R. J. McCauley (Eds.), *Interventions for speech sound disorders in children* (pp. 137–158). Baltimore, MD: Brookes.
- *Rvachew, S., & Brosseau-Lapré, F. (2010). Speech perception intervention. In A. L. Williams, S. McLeod, & R. J. McCauley (Eds.), *Interventions for speech sound disorders in children* (pp. 295–314). Baltimore, MD: Brookes.
- Sanetti, L. M. H., & Kratochwill, T. (2009). Toward developing a science of treatment integrity: Introduction to the special series. *School Psychology Review, 38*(4), 445–459.
- *Scherer, N. J., & Kaiser, A. P. (2010). Enhanced milieu teaching with phonological emphasis for children with cleft lip and palate. In A. L. Williams, S. McLeod, & R. J. McCauley (Eds.), *Interventions for speech sound disorders in children* (pp. 427–450). Baltimore, MD: Brookes.
- Schultz, K. F., Altman, D. G., Moher, D., & the CONSORT Group. (2010). CONSORT 2010 Statement: Updated guidelines for reporting parallel group randomized trials. *Annals of Internal Medicine, 152*(11), 726–732.
- *Stackhouse, J., & Pascoe, M. (2010). Psycholinguistic intervention. In A. L. Williams, S. McLeod, & R. J. McCauley (Eds.), *Interventions for speech sound disorders in children* (pp. 219–246). Baltimore, MD: Brookes.
- Swift, W. (1918). *Speech defects in school children*. Cambridge, MA: Riverside Press.
- Turkstra, L. S., Norman, R., Whyte, J., Dijkers, M. P., & Hart, T. (2016). Knowing what we're doing: Why specification of treatment methods is critical for evidence-based practice in speech-language pathology. *American Journal of Speech-Language Pathology, 25*(2), 164–171.
- *Tyler, A. A., & Haskill, A. M. (2010). Morphosyntax intervention. In A. L. Williams, S. McLeod, & R. J. McCauley (Eds.), *Interventions for speech sound disorders in children* (pp. 355–377). Baltimore, MD: Brookes.
- Van Stan, J. H., Roy, N., Awan, S., Stemple, J., & Hillman, R. E. (2015). A taxonomy of voice therapy. *American Journal of Speech-Language Pathology, 24*(2), 101–125.
- Ward-Horner, J., & Sturmey, P. (2010). Component analyses using single-subject experimental designs: A review. *Journal of Applied Behavior Analysis, 43*(4), 685–704.
- Warren, S. F., Fey, M. E., & Yoder, P. J. (2007). Differential treatment intensity research: A missing link to creating optimally effective communication interventions. *Mental Retardation and Developmental Disabilities Research Reviews, 13*(1), 70–77.
- Whyte, J., Dijkers, M. P., Hart, T., Zanca, J. M., Packel, A., Ferraro, M., & Tsaousides, T. (2014). Development of a theory-driven rehabilitation treatment taxonomy: Conceptual issues. *Archives of Physical Medicine and Rehabilitation, 95*(Suppl. 1), 524–532.
- *Williams, A. L. (2010). Multiple oppositions intervention. In A. L. Williams, S. McLeod, & R. J. McCauley (Eds.), *Interventions for speech sound disorders in children* (pp. 73–93). Baltimore, MD: Brookes.
- Williams, A. L., McLeod, S., & McCauley, R. J. (Eds.). (2010). *Interventions for speech sound disorders in children*. Baltimore, MD: Brookes.
- World Health Organization. (2001). *ICF: International classification of functioning, disability and health*. Geneva, Switzerland: Author.
- World Health Organization. (2007). *International classification of functioning, disability and health: Children and youth version: ICF-CY*. Geneva, Switzerland: Author.
- Yin, R. K. (2011). *Qualitative research from start to finish*. New York, NY: Guilford.

Appendix A

Instructions Provided to Authors of Chapters in Williams et al. (2010) for Describing Speech Sound Interventions That Were Used in the Two Phases of the Current Analysis

PHASE 1: Topics for describing the requirements and components of interventions for speech sound disorders that were used in the first phase of analysis

1. Practical Requirements (1–2 pages)

- a) Nature of sessions (Include frequency and length of sessions as well as whether the sessions are individual, group, school-based, home-based, etc.)
- b) Personnel (Identify both the primary clinician and other participants, training required of personnel involved, any materials that are required, and so on. Please also include discussion of how parents/families are used and trained. Additionally, specify the nature of involvement of participants beyond the clinician and child (e.g., the clinician, parents, peers, siblings, teachers). In the case of parent-administered interventions, the clinician's role should be specified.)

2. Key Components (5–8 pages)

- a) Nature of goals (e.g., broad goals of intervention and basis of target selection)
- b) Goal attack strategies (e.g., sequential, simultaneous, cyclical)
- c) Description of activities (e.g., procedural or operational description of activities within which the goals are addressed)
- d) Materials and equipment required

PHASE 2: Topics that were added for the second phase of analysis

3. Target Populations and Assessments for Determining Intervention Relevance*

- a) Assessment methods (i.e., used to establish the appropriateness of the intervention for the individual child. Where assessment methods associated with determining the appropriateness of the approach to the child are particularly detailed, use citations to supplement a brief overview of those methods.)

4. Theoretical Basis*

- a) Level of consequences being addressed (i.e., Is the intervention targeting a functional limitation directly or the social skill, activity, or social role restrictions that result from it? Interest in this distinction arises from work by the World Health Organization [2001, 2007].)
- b) Target areas of intervention (i.e., describe whether solely focusing on speech output or broader domains, such as perception, literacy, morphosyntax, cognition, etc.)

5. Assessment and Progress Monitoring to Support Decision Making (1–2 pages)

Recommended assessment techniques and data collection used for decision making within the method, such as whether progress is being made, when changes should be made to the treatment plan, and when treatment should be terminated

*Additional information was provided by the chapter authors under these headings; however, this additional information was not used in the current analysis.

Appendix B (p. 1 of 10)

Definition and Examples of Elements Comprising the Phonological Intervention Taxonomy

Domain	Category	Subcategory	Element	Definition of element	Example ^a
Goal	Focus	1.	Sound segment production	Goals focus on acquisition of sound segments, either as singletons and/or segments comprising consonant clusters.	<ul style="list-style-type: none"> • “intervention targets are typically consonants or consonant clusters” (E. Baker & Williams, 2010, p. 108: Complexity)
		2.	Phonological processes, patterns, rules, features, and/or sound classes	Goals focus on phonological processes (e.g., stopping of fricatives), phonological patterns (e.g., anterior/posterior contrasts), phoneme collapse rule set (e.g., voiceless obstruents and stop clusters collapsed to [t]), or phonological features and classes (e.g., continuants, major class features).	<ul style="list-style-type: none"> • “phonological patterns are presented and recycled as needed” (Prezas & Hodson, 2010, p. 145: Cycles) • “the multiple opposition approach addresses several target sounds from a phoneme collapse or rule set” (Williams, 2010, p. 84: Multiple Oppositions)
		3.	Phonotactics	Goals focus on phonological abilities beyond the segment (e.g., stress, syllable, and word shapes, between word processes).	<ul style="list-style-type: none"> • “New individual prosodic structures could entail new word lengths in syllables, new word and/or phrasal stress patterns, and/or new word shapes...” (Bernhardt, Bopp, Daudlin, Edwards, & Wastie, 2010, p. 324: Nonlinear)
		4.	Intelligibility/communicative effectiveness	Goals focus on overall intelligibility and successful communication.	<ul style="list-style-type: none"> • “goals are related to increases in functional intelligibility” (Camarata, 2010, p. 396: NIS) • “goals of treatment may include general communicative effectiveness” (Bernhardt et al., 2010, p. 324: Nonlinear)
		5.	Input processing/speech perception	Goals focus on input processing, such as speech perception and/or word recognition, as opposed to production.	<ul style="list-style-type: none"> • “SAILS [Speech Assessment and Interactive Learning System] addresses the child’s speech perception abilities” (Rvachew & Brosseau-Lapré, 2010, p. 302: Speech Perception)
		6.	Phonological awareness and literacy	Goals targeting one or more literacy-related abilities, such as phonemic awareness, letter/sound knowledge.	<ul style="list-style-type: none"> • “targeting a weak aspect of the model (e.g., auditory discrimination of a specific contrast)” (Stackhouse & Pascoe, 2010, p. 237: Psycholinguistics) • “goals of treatment may include... phonological awareness, such as the skills in identifying rhymes, onsets, segments, or syllable and rhythm patterns” (Bernhardt et al., 2010, p. 324: Nonlinear) • “incorporate explicit links between sounds and letters” (Stackhouse & Pascoe, 2010, p. 239: Psycholinguistics)
		7.			

(table continues)

Appendix B (p. 2 of 10)

Definition and Examples of Elements Comprising the Phonological Intervention Taxonomy

Domain	Category	Subcategory	Element	Definition of element	Example ^a
			Other linguistic abilities	Goals addressing broader linguistic or communicative abilities (e.g., morphosyntax, vocabulary, social-conversational/pragmatic abilities, such as responsiveness, and ability to initiate and maintain conversation).	<ul style="list-style-type: none"> • “increase the likelihood that the child will initiate and maintain communicative interaction” (Scherer & Kaiser, 2010, p. 439: EMT/PE) • “thoughtfully selected morpheme goals” (Tyler & Haskill, 2010, p. 365–366: Morphosyntax) • “targets for which a child shows readiness and stimulability should be selected” (Prezas & Hodson, 2010, p. 146: Cycles)
	Characteristics of goal/target	8.	Stimulable sounds	Speech sound that a child is able to imitate when provided with auditory, visual, and/or tactile cues (Williams, McLeod, & McCauley, 2010, p. 618).	<ul style="list-style-type: none"> • “nonstimulable sounds are considered to be more complex and worth prioritizing over stimulable sounds” (E. Baker & Williams, 2010, p. 104: Complexity) • “for some children target selection is conservative and traditional, respecting developmental expectations and most phonological knowledge” (Bowen, 2010, p. 421: PACT)
		9.	Nonstimulable sounds	Speech sound that a child is unable to imitate when provided with auditory, visual, and/or tactile cues (Williams et al., 2010, p. 618).	<ul style="list-style-type: none"> • “intervention targets are typically consonants or consonant clusters that are... later developing” (E. Baker & Williams, 2010, p. 108: Complexity)
		10.	Early developing sounds	Speech sounds that are relatively earlier developing (e.g., /p, b, m, n/).	<ul style="list-style-type: none"> • “intervention targets are typically consonants or consonant clusters that are... consistently in error” (E. Baker & Williams, 2010, p. 108: Complexity)
		11.	Later developing sounds	Speech sounds that are relatively later developing (e.g., /l, s, j, θ/).	<ul style="list-style-type: none"> • “targets should be included that are produced correctly some of the time” (Miccio & Williams, 2010, p. 191: Stimulability)
		12.	Sounds always incorrect	Speech sounds that are not used by a child and, as such, always in error in words (e.g., <i>key</i> /ki/ → [ti]; <i>bucket</i> /bʌkət/ → [bʌtət]; <i>bike</i> /baɪk/ → [bait]).	<ul style="list-style-type: none"> • “for children who make inconsistent errors” (Dodd, Holm, Crosbie, & McIntosh, 2010, p. 123: Core Vocabulary)
		13.	Sounds sometimes correct	Sounds that a child has some productive phonological knowledge of as evidenced by occasional use in words (e.g., <i>key</i> /ki/ said as [ti] on five occasions and [ki] once).	
		14.	Lexical inconsistency	Inconsistency is evident when a word is pronounced differently on at least one of three trials (e.g., <i>feet</i> [fi], [bit], [bi]).	

(table continues)

Appendix B (p. 3 of 10)

Definition and Examples of Elements Comprising the Phonological Intervention Taxonomy

Domain	Category	Subcategory	Element	Definition of element	Example ^a
			15. Broader factors beyond sound segment	Factors influencing goal/target broader than or beyond the sound segment, which could include phonotactic structures (e.g., consonant clusters, weak syllables, stress patterns), groups of phonemes collapsed within a rule set, intelligibility, phonological awareness abilities, and other linguistic domains.	<ul style="list-style-type: none"> • “multiple oppositions approach addresses several target sounds from a phoneme collapse, or rule set, within larger contrastive treatment stimuli” (Williams, 2010, p. 84: Multiple Oppositions) • “syllableness ... is a target for children who speak in monosyllables” (Prezas & Hodson, 2010, p. 148: Cycles) • “the broad goal... is to increase the child’s awareness of word forms... with the aim of facilitating speech change and literacy acquisition” (Hesketh, 2010, p. 263: Metaphonology)
	Linguistic context		16. Isolated speech sounds or articulatory movements	Production of specific speech sounds in isolation (e.g., [s:::]) or in a syllable (e.g., [be]) or specific mouth movement.	<ul style="list-style-type: none"> • “sounds are taught in isolation (e.g., [s:::]) or CV contexts (e.g., [kʌ kʌ kʌ]) for stops and glides” (Miccio & Williams, 2010, p. 190: Stimulability) • “limited activities to direct oral airflow, such as limited use of low resistance blowing toys” (Scherer & Kaiser, 2010, p. 438: EMT/PE)
			17. Nonwords	Nonwords (i.e., nonsense words) that may or may not be assigned lexical meaning during intervention.	<ul style="list-style-type: none"> • “NSWs [nonsense words] serve as the treatment word stimuli” (E. Baker & Williams, 2010, p. 109: Complexity)
			18. Real words	Real words that may or may not be meaningful to the child.	<ul style="list-style-type: none"> • “the multiple oppositions approach incorporates picture stimuli of real words, although occasionally nonsense words are used” (Williams, 2010, p. 88: Multiple Oppositions)
			19. Sentences	Production of a target speech sound or phonological pattern beyond the single-word level—phrases and sentences.	<ul style="list-style-type: none"> • “consistency of production is extended to sentence frames and spontaneous speech” (Dodd et al., 2010, p. 130: Core Vocabulary)
			20. Conversation	Production of a targeted speech production skill (e.g., specific sound, syllable shape, stress pattern, intelligibility) or other linguistic ability during conversational speech.	<ul style="list-style-type: none"> • “The later phases (Phase 3 and Phase 4) place more emphasis on the contrastive function of the target sounds within communication and conversational contexts” (Williams, 2010, p. 87: Multiple Oppositions)
			21. Contrastive words	Two or more words used in a contrastive way to highlight the function of phonemes.	<ul style="list-style-type: none"> • “challenged to produce a contrast between the word pairs in order to be understood” (E. Baker, 2010, p. 61: Minimal Pairs)

(table continues)

Appendix B (p. 4 of 10)

Definition and Examples of Elements Comprising the Phonological Intervention Taxonomy

Domain	Category	Subcategory	Element	Definition of element	Example ^a
			22. Written letters, words, or sentences	Written letters/graphemes, words and/or sentences used to target phonological awareness/literacy goal.	<ul style="list-style-type: none"> • "...graphemes will be used and mentioned more and more as children become more familiar with literacy at school" (Hesketh, 2010, p. 265: Metaphonology) • "letter-sound relationships in the text" (Hoffman & Norris, 2010, p. 347: Dynamic Systems)
	Goal progression strategy		23. Vertical	Intervention targeting one phoneme or one specific pattern/process per session until predetermined performance criteria has been met (i.e., sequential progression).	<ul style="list-style-type: none"> • "intervention goals have most frequently been implemented within a sequential goal attack strategy (one phoneme or pattern at a time)" (E. Baker, 2010, p. 60: Minimal Pairs)
			24. Horizontal	Intervention targeting two or more phonemes from different classes or different patterns/processes within a session (i.e., simultaneous progression).	<ul style="list-style-type: none"> • "a horizontal goal attack strategy...is incorporated with the stimulability intervention program, as all consonants are addressed within each therapy session" (Miccio & Williams, 2010, p. 190: Stimulability)
			25. Cyclical	A range of goals are worked on within a period of time but not at the same time (e.g., goals change weekly) and may be re-visited for another period of time according to need.	<ul style="list-style-type: none"> • "deficient phonological patterns from prior cycles are recycled as many times as needed" (Prezas & Hodson, 2010, p. 145: Cycles)
Teaching moment	Antecedent event (clinician)	Content of model or instruction	26. Articulatory-phonetic	Clinician provides a model of the target phone/speech sound, syllable structure or stress pattern, and/or instruction (cues/prompts) about how to articulate the phonetic target. The modality of the model may vary (e.g., spoken, visual, tactile-kinesthetic, gestural).	<ul style="list-style-type: none"> • "the /ɹ/ is modeled for the child" (Prezas & Hodson, 2010, p. 149: Cycles) • "phonetic placement cues are used to shape the child's production of the target sound" (Miccio & Williams, 2010, p. 195: Stimulability)
			27. Phonological	Clinician provides a model and/or information about the phonological target, focusing a child's attention on the function of phonemes.	<ul style="list-style-type: none"> • "The SLP shows the child the picture for each word, saying, for example, 'This is a ring, we wear it on our finger. This is a wing on a bird.'" (E. Baker, 2010, p. 61: Minimal Pairs)
			28. Metaphor	Clinician provides a verbal analogy, such as /j/ is the quiet sound, to make abstract phonological or phonetic aspects of a target easier to understand.	<ul style="list-style-type: none"> • "the growling /ɹ/ sound" (E. Baker, 2010, p. 62: Minimal Pairs)
			29. Phonological awareness/literacy	Clinician provides phonological awareness and/or literacy-related instruction.	<ul style="list-style-type: none"> • "Tell me the first sound in...Find me all the words beginning with..." (Hesketh, 2010, p. 264: Metaphonology) • "the clinician would explain that the name Joseph has two syllables" (Dodd et al., 2010, p. 130: Core Vocabulary)

(table continues)

Appendix B (p. 5 of 10)

Definition and Examples of Elements Comprising the Phonological Intervention Taxonomy

Domain	Category	Subcategory	Element	Definition of element	Example ^a
			30. Semantic/morphologic/syntactic	Clinician provides a model, instruction, cloze task, forced choice, or focused stimulation for a semantic, morphologic, and/or syntactic target.	<ul style="list-style-type: none"> • “Modeling and mand-model procedures provide a means of structuring a child’s responses to facilitate the use of target vocabulary” (Scherer & Kaiser, 2010, p. 440: EMT/PE) • “the clinician may present a forced choice prompt such as, ‘Tell me what Jenny does with the flower seeds. She plants them or she waters them?’” (Tyler & Haskill, 2010, p. 368: Morphosyntax)
		Modality of model and/or instruction	31. Spoken	Clinician provides verbal instruction, description, and/or auditory model of targeted skill (e.g., phonetic, phonological, phonological awareness, semantic/morphologic).	<ul style="list-style-type: none"> • “clinicians should provide information about the plan, requiring children to generate their own plan for the word” (Dodd et al., 2010, p. 131: Core Vocabulary) • “Adult says, “key rhymes with...” (Bowen, 2010, p. 416: PACT)
			32. Visual	Clinician provides a visual referent (e.g., pictures, objects, written words) relevant to the target skill.	<ul style="list-style-type: none"> • “holds the morphophonemic vocabulary card for lick below the written word” (Hoffman & Norris, 2010, p. 349: Dynamic Systems) • “the clinician presents each character card one at a time” (Miccio & Williams, 2010, p. 195: Stimulability)
			33. Tactile/kinesthetic	Clinician provides a manual cue to physically assist the child in the articulation of a target sound (e.g., clinician gently draws client’s cheeks forward to facilitate rounding of the lips to articulate /f/; use of a tongue depressor to touch the child’s alveolar ridge to highlight placement for /l/). In contrast to gestural modality, tactile–kinesthetic modality involves physical touch of the child’s mouth or manual guidance (Hegde, 1985). This cue could be provided before or during the child’s response.	<ul style="list-style-type: none"> • “Plugging the nose may assist the child to direct the airstream through the mouth.” (Scherer & Kaiser, 2010, p. 438: EMT/PE)
			34. Gestural	Clinician provides a physical movement or gesture with their hands to highlight a specific articulatory or phonological characteristic of the target (e.g., long–short movement with hands to highlight fricative vs. stop; tapping the number of syllables in a word; using hands to model the placement of the tongue relative to the palate; using hands to move objects together to symbolize two consonants in a cluster).	<ul style="list-style-type: none"> • “using stress and intonation paired with physical prompts of the new contrasts to be learned (e.g., contrasting long and short arm movements coinciding with the production of fricative and stop sounds)” (Williams, 2010, p. 85: Multiple Oppositions) • “Two linked-up characters move together, each pronouncing their part of the cluster: [s][n]” (Bernhardt et al., 2010, p. 325: Nonlinear)

(table continues)

Appendix B (p. 6 of 10)

Definition and Examples of Elements Comprising the Phonological Intervention Taxonomy

Domain	Category	Subcategory	Element	Definition of element	Example ^a
	Response (child)	Response level	35. Imitation	Child imitates or repeats the clinician's production of targeted skill.	<ul style="list-style-type: none"> • "During the imitation phase, a child is instructed to repeat the clinician's model" (E. Baker & Williams, 2010, p. 109: Complexity)
			36. Spontaneous	Child's production is said without an auditory model in the clinician's antecedent utterance.	<ul style="list-style-type: none"> • "During the spontaneous phase, the child is instructed to provide the same treatment words independently without a model" (E. Baker & Williams, 2010, p. 109: Complexity)
		Response requirement	37. Verbal: phonetic production (speech sound/s)	Child articulates a specific speech sound.	<ul style="list-style-type: none"> • "the child imitates the prolonged [i]" (Hoffman & Norris, 2010, p. 349: Dynamic Systems) • "Articulation work if necessary to allow the child to produce the target sounds in isolation and in simple words" (Hesketh, 2010, p. 265: Metaphonology)
			38. Verbal: phonological production (words +)	Child produces a targeted phonological skill in a word, phrase, or sentence.	<ul style="list-style-type: none"> • "A foundational component is that the child produces spontaneous word attempts followed by an adult recast that models correct production at the word level" (Camarata, 2010, p. 396: NISI)
			39. Phonological awareness/literacy	Child identifies a particular letter or engages in a phonological awareness task, such as producing rhyming words, or segmenting/blending at the phonemic level. The response could be verbal and/or nonverbal (e.g., pointing, matching, sorting).	<ul style="list-style-type: none"> • "silent sorting of 10 cards into rhyming pairs" (Bowen, 2010, p. 417: PACT) • "Commonly used tasks requiring awareness of word-initial phonemes include...initial phoneme isolation (e.g., 'Tell me the first sound in...')" (Hesketh, 2010, p. 264: Metaphonology)
			40. Nonspeech: Prearticulatory/mouth movement	Child produces a mouth movement prior to articulating or in anticipation of articulating a specific speech sound.	<ul style="list-style-type: none"> • "/l/ is fairly easy to elicit after the child has been taught to click his or her tongue independent of jaw movement" (Prezas & Hodson, 2010, p. 149: Cycles)
			41. Auditory/listening	The child listens and responds via pointing, selecting, or manipulating a picture or object, or making a judgment about clinician's prior utterance. Child's response requires metalinguistic awareness (e.g., pointing to pictures said by clinician; right/wrong judgment about a clinician's speech) that differs from routine phonological awareness/literacy tasks.	<ul style="list-style-type: none"> • "the child hears the recording of a word" (Rvachew & Brosseau-Lapr�e, 2010, p. 306: Speech Perception) • "You be the teacher and tell me if I say these words the right way or the wrong way" (Bowen, 2010, p. 417: PACT)
			42. Gestural	Use of specific gestures or hand movements that may or may not accompany attempted production of targeted speech skill.	<ul style="list-style-type: none"> • "Clinician and child take turns producing the sound and associated [hand] motion of the character" (Miccio & Williams, 2010, p. 194: Stimulability)

(table continues)

Appendix B (p. 7 of 10)

Definition and Examples of Elements Comprising the Phonological Intervention Taxonomy

Domain	Category	Subcategory	Element	Definition of element	Example ^a		
Context	Intervention agent	Evaluative feedback	43.	Knowledge of results	Child is given feedback regarding the accuracy of response (i.e., correct/incorrect) that may include praise or encouragement.	<ul style="list-style-type: none"> • “Like, you got it!” (Hoffman & Norris, 2010, p. 350: Dynamic Systems) • “That’s right, soap has an [s]...” (Hesketh, 2010, p. 267: Metaphonology) • “the clinician can...explicitly explain that the word differed and how it differed” (Dodd et al., 2010, p. 131: Core Vocabulary) • “occasionally, phonetic placement cues are used to shape the child’s production of the target sound” (Miccio & Williams, 2010, p. 195: Stimulability) 	
			44.	Knowledge of performance	Child is given feedback about why their response was correct or incorrect. For example, if the child’s response was incorrect, this instruction might tell the child how to articulate the target speech sound in the word via placement cues and/or provide the child with information about what makes a particular speech sound contrastive relative to another speech sound. Knowledge of performance could be used to shape a child’s response toward a more accurate response.		
			45.	Request for the child’s self-judgment/ self-monitoring	The child is instructed to judge, self-monitor, and/or repair his or her own utterances containing speech production errors.	<ul style="list-style-type: none"> • “feedback is delayed using semantic confusion and wrong clinician models to encourage self-monitoring” (Williams, 2010, p. 87: Multiple Oppositions) • “fixed-up-one routine” (Bowen, 2010, p. 417: PACT) 	
			Responsive feedback	46.	Recast/expansion	Recast is the repetition of a child’s utterance, using appropriate phonological, grammatical, syntactic forms (Camarata, 1995); expansion is an utterance that adds information or expands upon a child’s utterance.	<ul style="list-style-type: none"> • “speech recasts are those recasts that provide correct phonological information in response to a child’s incorrect production” (Scherer & Kaiser, 2010, p. 438: EMT/PE) • “the clinician is encouraged to respond with a simple expansion recast (repetition of the child’s utterance but using the correct grammatical form) or with a ‘growth recast’...emphasizing the correct adult form in a new complete sentence that expands on the child’s original utterance” (Tyler & Haskill, 2010, p. 369: Morphosyntax)
		47.	Speech-language pathologist (SLP)	Qualified SLP.	<ul style="list-style-type: none"> • Assessment and intervention “should be implemented by a certified SLP” (Prezas & Hodson, 2010, p. 146: Cycles) 		
		48.	Parent	Child’s parent or caregiver.	<ul style="list-style-type: none"> • “The personnel involved in PACT are the child, primary caregiver(s), and the speech-language pathologist (SLP)” (Bowen, 2010, p. 417: PACT) • “child’s family and teacher...both must be involved from the outset of intervention” (Dodd et al., 2010, p. 128: Core Vocabulary) 		
49.	Teacher	Child’s teacher constitutes a trained early childhood, special education, or classroom teacher.					

(table continues)

Appendix B (p. 8 of 10)

Definition and Examples of Elements Comprising the Phonological Intervention Taxonomy

Domain	Category	Subcategory	Element	Definition of element	Example ^a
			50. Other children	Other children include siblings, cousins, friends, or peers.	<ul style="list-style-type: none"> • “parents and siblings have participated in intervention” (Miccio & Williams, 2010, p. 189: Stimulability)
			51. Other agents	Others could include untrained personnel, teachers’ aids, paraprofessionals, and SLP assistants.	<ul style="list-style-type: none"> • “can be delivered by assistants or parents” (Stackhouse & Pascoe, 2010, p. 234: Psycholinguistics)
	Venue		52. Clinic	Clinic is the SLP’s routine work location, such as a community health center, school clinic (not including classroom), hospital, university teaching clinic, or private practice setting.	<ul style="list-style-type: none"> • “session can be completed in clinic...” (Camarata, 2010, p. 394: NISl) • “university phonology clinics” (Prezas & Hodson, 2010, p. 146: Cycles)
			53. Home	Home refers to the location where the child lives.	<ul style="list-style-type: none"> • “session can be conducted in the clinic, home, and classroom settings” (Camarata, 2010, p. 394: NISl)
			54. School	School setting may include early childhood (e.g., preschool), elementary, middle, or high school classroom environment.	<ul style="list-style-type: none"> • “designed to be implemented in early childhood, elementary school, or clinical settings” (Tyler & Haskill, 2010, p. 365: Morphosyntax)
	Format		55. Individual	Intervention provided one-to-one between child and intervention agent (clinician, caregiver, or paraprofessional).	<ul style="list-style-type: none"> • “the intervention is provided individually” (Rvachew & Brosseau-Lapr�, 2010, p. 304: Speech Perception)
			56. Group	Intervention provided to two or more children by one or more intervention agents.	<ul style="list-style-type: none"> • “the morphosyntax approach is structured to include one individual and one small-group session per week” (Tyler & Haskill, 2010, p. 365: Morphosyntax)
	Resources		57. Paper based (e.g., books, cards)	Paper-based materials includes books, cards, information handouts, pamphlets or letters for parents, activity sheets, probe lists, analysis forms, data collection sheets, and homework instructions.	<ul style="list-style-type: none"> • “two large boxes of 1,800 picture cards involving four sets of 450 different images and 550 line-drawn worksheets” (Stackhouse & Pascoe, 2010, p. 171: Psycholinguistics)
			58. Objects	Items used in intervention, such as toys, board games, props for pretend play, art and craft items, and motivating rewards, such as stickers and stamps.	<ul style="list-style-type: none"> • “table top games such as lotto, posting cards in a letterbox, card games, or ‘fishing’ for cards” (Stackhouse & Pascoe, 2010, p. 172: Psycholinguistics)
			59. Scripts	Scripts are examples of dialogue between a clinician and a child that guides the therapeutic conversation.	<ul style="list-style-type: none"> • “detailed scripts for use during different elicitation activities” (Tyler & Haskill, 2010, p. 369: Morphosyntax)
			60. Computer/ technology	Technology used during intervention sessions such as laptop or desktop computers, amplification devices, headphones, audio and/or video-recording devices.	<ul style="list-style-type: none"> • “stimuli should always be presented to the child through good quality headphones” (Rvachew & Brosseau-Lapr�, 2010, p. 306: Speech Perception)

(table continues)

Appendix B (p. 9 of 10)

Definition and Examples of Elements Comprising the Phonological Intervention Taxonomy

Domain	Category	Subcategory	Element	Definition of element	Example ^a	
Procedural issues	Activities	Type	61. Naturalistic activities	Naturalistic activities involve play within a social communicative context. The environment may be strategically arranged and/or the interaction may be child or clinician directed. Naturalistic activities do not include games.	<ul style="list-style-type: none"> • “this is a child-led approach...the clinician should set up the environment in such a manner that the child will naturally attempt to communicate” (Camarata, 2010, p. 394: NISI) 	
			62. Structured activities	Structured activities are typically preset clinician-directed tasks or games. Such activities may have a predetermined dose (e.g., 100 production practice trials). Activities may be sequenced hierarchically, such that completion of one activity is contingent upon commencing another.	<ul style="list-style-type: none"> • “Using the five target words, the child is instructed to name each picture without a model...This step continues until the child achieves 50% accuracy independently producing the target words in at least 50 trials” (E. Baker, 2010, p. 62: Minimal Pairs) 	
		Social/emotional valence	63. Challenging	An aspect of intervention (specifically with respect to producing a particular speech sound or experiencing a breakdown in communication) may be challenging or somewhat frustrating for a child for motivating the child to communicate.	<ul style="list-style-type: none"> • “if a child has the phonetic ability to produce the word, then the frustration sometimes experienced by children when confronted with the homonymy in their speech might be minimized using the perception-production approach” (E. Baker, 2010, p. 63: Minimal Pairs) 	
	Intensity ^b			64. Fun	Aspects of intervention are designed for the child to experience fun and enjoyment.	<ul style="list-style-type: none"> • “props, costumes, wands, and a warped sense of fun-ology” (Bernhardt et al., 2010, p. 326: Nonlinear)
				65. Session frequency	How often intervention sessions are scheduled per unit of time, typically per week.	<ul style="list-style-type: none"> • “one individual and one small-group session per week” (Tyler & Haskill, 2010, p. 365: Morphosyntax)
				66. Session duration	The period of time of an intervention session, typically measured in minutes or hours.	<ul style="list-style-type: none"> • “the child’s exposure to SAILS lasted no longer than 15 minutes in any given session” (Rvachew & Brosseau-Lapr�e, 2010, p. 305: Speech Perception)
				67. Dose per session	The number of times an element (e.g., production of a targeted phonological skill in a word) or a teaching episode containing a combination of active elements occurs per session (Warren, Fey, & Yoder, 2007).	<ul style="list-style-type: none"> • “sessions would typically consist of 20 trials of each of the five target words... totaling 100 trials” (E. Baker, 2010, p. 62: Minimal Pairs) • “clinicians aim to provide, at minimum, 40 correct (non contrasting or erroneous) examples of the targeting form” (Tyler & Haskill, 2010, p. 367: Morphosyntax)

(table continues)

Appendix B (p. 10 of 10)

Definition and Examples of Elements Comprising the Phonological Intervention Taxonomy

Domain	Category	Subcategory	Element	Definition of element	Example ^a
Procedural issues	Training	68.	Total intervention duration	The total period of intervention measured in time (e.g., weeks, months, years) or total numbers of sessions (e.g., 21 sessions) required or recommended to treat SSD in children.	<ul style="list-style-type: none"> • “a clinician should not expect to exceed 16 half-hour sessions” (Dodd et al., 2010, p. 129: Core Vocabulary)
		69.	SLP prerequisite knowledge/specific training requirements	Authors of an approach indicate that additional training is required beyond professional training needed to qualify as an SLP. The training may be either a structured course leading to certification to use an approach, or informal training, supervision, or practice.	<ul style="list-style-type: none"> • “It is recommended that clinicians administer EMT/PE procedure with three children in order to gain sufficient experience with procedures to optimize training effectiveness and enhance credibility with parents” (Scherer & Kaiser, 2010, p. 436: EMT/PE)
	Evaluation	70.	Non-SLP personnel prerequisite knowledge/specific training requirements	Authors of an approach indicate that non-SLP personnel require training to use the approach. The training may be either a structured course with predetermined content and sequence or unstructured informal training with a clinician.	<ul style="list-style-type: none"> • “well-defined EMT training sequence for parents that takes 20–36 sessions (depending on parent pretreatment skills) to reach criterion on all components of the program” (Scherer & Kaiser, 2010, p. 436: EMT/PE)
		71.	Criterion-based progression	An approach has a predetermined sequence of stages, and specific criteria need to be met to progress from one stage to another. Progression may be explicit (e.g., must achieve 70% accuracy) or less strict and subject to clinician’s discretion.	<ul style="list-style-type: none"> • “A training criterion is specified for changing from imitation to spontaneous production in Phase 2, which is 70% accuracy across two consecutive training sets” (Williams, 2010, p. 87: Multiple Oppositions)
		72.	Prescribed data collection	Child’s progress is to be evaluated using a prescribed data collection schedule, detailing the type and frequency of data to be collected.	<ul style="list-style-type: none"> • “probes may be taken at the end of a session or on a weekly schedule” (Hoffman & Norris, 2010, p. 350: Dynamic Systems)

Note. NISI = naturalistic intervention for speech intelligibility; EMT/PE = enhanced milieu teaching with phonological emphasis; PACT = Parents and Children Together; SSD = speech sound disorders.

^aTypically, one example is provided per ingredient. Where an ingredient could be exemplified in more than one way, additional examples are provided. ^bIntensity parameters (dose, session duration, session frequency, total intervention duration) on the basis of Warren et al. (2007).