Bringing learning progressions down to 2-year-olds in reading and mathematics

Prue Anderson
Australian Council for Educational Research

https://doi.org/10.37517/978-1-74286-715-1-10

Prue Anderson is a Principal Research Fellow at the Australian Council for Educational Research. Prue has worked on humanities-based assessments and large-scale international projects. In the last 10 years she has focused on early years' literacy including developing assessments, curricula and teaching materials. Prue was a key author in the development of the ACER Learning Progressions for reading, listening comprehension, sounds and symbols and oral language. These are globally applicable descriptions of how literacy skills develop across these domains. She recently worked with the Queensland Education Department to help develop Kindergarten learning progressions in language, mathematics, executive function, social and emotional skills, and physicality. She has also helped refine the Global Proficiency Framework and led the development of reading text complexity samples and reading item examples from grades 2–9. Prue has a background in lower primary teaching and in teaching undergraduate primary teachers.

Abstract

ACER's learning progressions in reading and mathematics describe growth that is mainly focused on the skills students demonstrate at and beyond school. These progressions have recently been extended down to describe earlier levels of growth so we now have seamless progressions from skills and understandings toddlers might demonstrate up to highly sophisticated skills and concepts. This presentation briefly outlines ACER's work and identifies key implications for educators. The pathways that support early reading development were described in progressions for listening comprehension, and sounds and letters. Along with an early mathematics progression, these were conceptualised as embedded in an oral language progression. Educators need to understand what early growth in reading and mathematics looks like in order to foster key skills and concepts at an appropriate level for the child. This ensures a strong foundation for children to make good ongoing progress.

Background

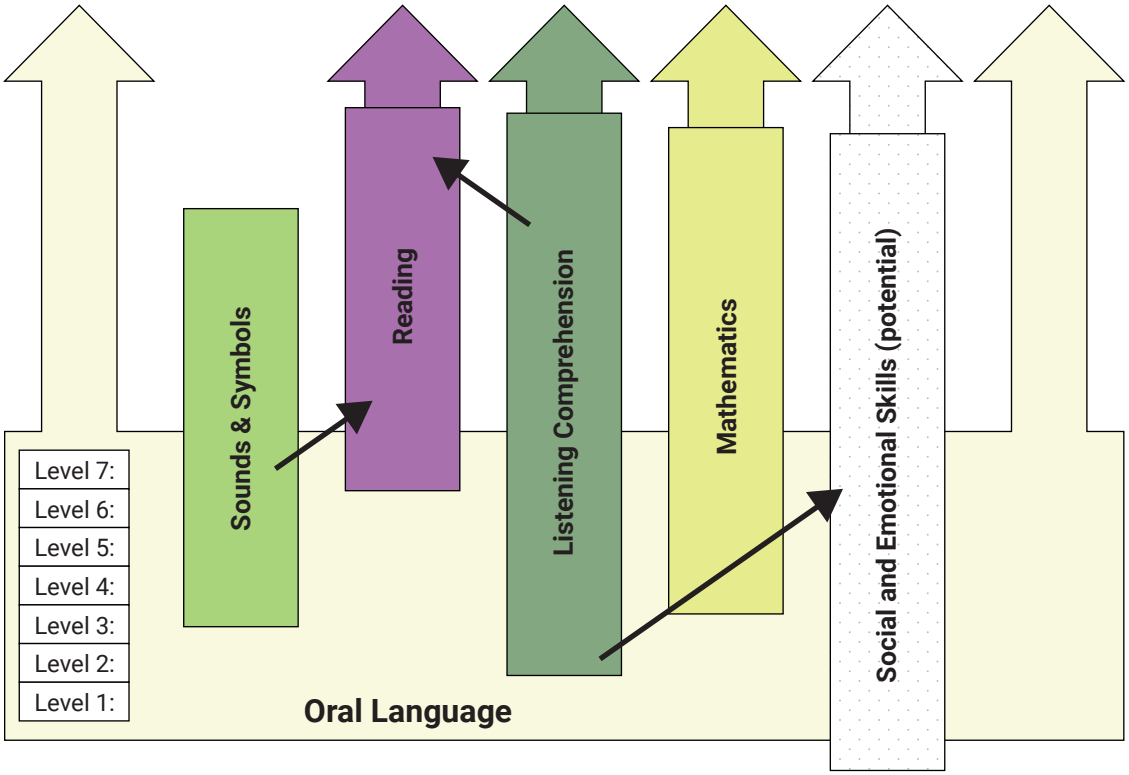
ACER has developed learning progressions (LPs) in reading and mathematics that describe the progressive development of key skills and concepts in these domains across the years of school and beyond. LPs support educators to focus on core skills, interpret their observations of what children can do in the context of a broad understanding of where this observation fits in a learning progression, identify what other skills the child also needs to master before they are ready to progress, and identify what is the most appropriate next step in learning. In recent months we have been focused on extending the ACER LPs downwards to describe developmentally appropriate, conceptually sound, age-appropriate skills and understandings young children can be supported to learn. It is not about starting the school curriculum sooner, rather the lower levels show how to prepare a sound foundation for ongoing cognitive growth. They also show that there is a continuous progression of development in these domains rather than a hiatus between preschool and school.

Oral language

Oral language is foundational

There is extensive research evidence of the critical role of oral language in underpinning early cognitive development. To describe the lower levels of the LPs, we have conceptualised the starting points of the Reading and Mathematics LPs as embedded in an Oral Language LP. This is shown in Figure 1.

Figure 1 ACER LPs embedded in oral language with potential location of a social and emotional skills LP



At the lower levels, where the LPs sit within the Oral Language LP, we have differentiated the development of domain-general oral language skills and domain-specific language and concepts. The main distinction concerns conceptual understanding, which often underpins domain-specific language. Some vocabulary may be commonly used in the child's everyday contexts making it domain general, but it may also have a domain-specific meaning that children can learn. For example, in mathematical spatial language 'on' has a very specific meaning referring to relative position where one object is in contact with and supported by another object, whereas in everyday contexts 'putting your shoes on' means covering most of the foot with a shoe including the soles of the shoes being under your feet. Similarly, 'turning the lights on' means flicking a switch, and 'go on' is an encouragement to try or continue an action. Domain-specific language development is primarily focused on using language to build deep understanding of domain-related concepts with children who also need to understand any differences in domain-general use of the same vocabulary.

In the process of describing lower levels of the Reading LP, we found it necessary to split off Listening Comprehension, and Sounds and Symbols as separate LPs serving as pathways to reading. This is because children's skills in listening comprehension and their understanding of sounds and symbols do not necessarily develop in parallel. Figure 1 also illustrates the potential

placement of a social and emotional skills LP and its close relationship with oral language and listening comprehension, shown with a dotted fill. Social and emotional skill development begins before children can speak as they learn to smile in response to others and to share a common gaze. A Writing LP, currently being drafted, can be added, as this too is embedded in oral language and influenced by skills developed in Sounds and Symbols and Listening Comprehension.

Oral Language LP

The Oral Language LP describe domain-general language skills up to level 7. Level 1 starts with babies' first attempts to vocalise, moving from imitation of sounds and responses to words as they start to talk and understand speech. By level 4, young children can generally make themselves understood and show understanding of most words heard in everyday contexts. At this point they can also begin to develop age-appropriate, domain-specific language and concepts that are described in the lowest levels of some of the respective LPs (embedded in the domain-general Oral Language LP). For example, children who listen to stories learn that print remains constant, and start to learn how to process and understand very simple stories long before they are ready to learn to read themselves. Not all LPs are aligned with level 4 of the Oral Language LP as the starting point; some, such as Reading, require higher levels of general oral language skill.

We recognise that domain-general oral language skills continue to develop but have described this up to level 7 only. This level describes skills a proficient language user might demonstrate at the start of school. We described up to this level only for the purposes of highlighting the general language skills young children also need to support learning domain-specific language skills and concepts before they start school.

Development across the domain-specific skills is not necessarily concurrent. A child may show minimal development in one domain and extensive skill development in another. However, any development is contingent on the child being given opportunities to learn and develop both domain-general and specific language skills and concepts. Children need good language models. They need to interact with more competent language users who also have a clear understanding of what progress looks like and how best to support them to improve.

Why oral language matters

Oral language is pivotal in the early development of literacy and mathematics, and there is a strong reciprocal relationship between the development of oral language and the development of social and emotional skills and executive function. There is also evidence of the reciprocity of executive function skills, and early literacy and mathematical skill development in preschool settings (Fuchs et al., 2010; Welsh et al., 2010) that mirrors evidence of this relationship with primary children (Blair et al., 2015; Kieffer et al., 2013).

Oral language has been described as the 'substrate for literacy' (Christensen, 2016; Snow 2021). The development of all aspects of literacy from speaking and listening through to reading and writing rely on the development of oral language. Low levels of oral language skill in preschool settings predict poor future reading comprehension outcomes (Catts et al., 2006; Elwér et al., 2015; Nation et al., 2010). The impact of early oral language skills on reading proficiency is initially indirect and only evident in the longer term (Castles et al., 2018; Dickenson et al., 2010). Many longitudinal studies have shown that oral language proficiency on school entry predicts later reading comprehension success (Hulme et al., 2015; Lervåg et al., 2017; Storch & Whitehurst, 2002; Walker et al., 1994). Recent research has also highlighted the interdependence of reading and mathematical development (Sarama et al., 2012), with strong relationships apparent as early as preschool and kindergarten (McClelland et al., 2007).

Early mathematical development is supported by language skills that enable children to represent and understand quantities as well as make comparisons of relative magnitude (Miura & Okamoto, 2003). Early parent 'number talk' involving informal conversations about numbers and quantities has a strong relation to children's later understanding of cardinal[1] values of number words (Levine et al., 2010; Mix, 2008; Mix et al., 2005). Knowledge of certain language terms specific to mathematics (for example, more and few) predicts mathematics development (Purpura & Logan, 2015). Counting and the application of simple computational skills (such as combining groups or removing part of a group) appear to correlate with phonological processing skills (Fuchs et al., 2010; Hecht et al., 2001), as both are related to the development of working memory and attention regulation (Moll et al., 2016).

Morgan's longitudinal study of a population-based sample of 8,650 children showed 24-month-old children with larger oral vocabularies displayed greater reading and mathematics achievement, increased behavioural self-regulation, and fewer externalising and internalising problems at kindergarten entry (Corredor et al., 2017; Morgan et al., 2015). There is much evidence of a strong bi-directional, or reciprocal, association between language, and social and emotional development (Morgan et al., 2015; Rojas & Abenavoli, 2021; Salmon et al., 2016; Vitiello & Williford, 2016). The promotion of expressive and receptive language through developing vocabulary, syntax, and early literacy and mathematical concepts also provides a foundation for the executive function skills of reasoning and reflecting on experiences (Blair, 2016).

Effective preschool educational programs and interventions must support comprehensive oral language development (Beitchman & Brownlie, 2010; Cohen, 2010; Morgan et al., 2015; Slot et al., 2020). Children need opportunities to interact with better language users to expand their vocabulary, understanding and use of different language structures (Hart & Risley, 1995; Morrow & Rand, 1991). Neuman (2004) found that children identified as early readers when entering school came from contexts filled with lively, interactive conversation. Preschool teachers and parents can actively develop students' language skills by modelling the use of more sophisticated vocabulary and complex syntax, and engaging them in talk about books as well as conversations about early mathematical concepts.

Lower-level skills in the LPs

The next section summarises the progressive development of some of the key skills and concepts described in the lower levels of the LPs illustrated in Figure 1. These level descriptions help educators working with preschool children to support comprehensive development of children's general and domain-specific oral language.

Early literacy language skills

The Listening Comprehension LP focuses on the development of language skills that allow children to listen to, understand and talk about the ideas in age-appropriate children's stories that are read to them. This starts with simple responses to very simple texts slowly building up to discussing extended texts with more complex language structures, implied ideas and a wide vocabulary. These skills need to be learnt. Written texts are not the same as everyday conversations. Children have to learn how to interpret ideas, make inferences and follow narrative structures in well-crafted, good-quality texts. They also need broad, rich background knowledge to support their understanding. Good-quality children's literature exposes children to more complex sentence constructions and

1 Cardinality means recognising that the final count represents the total number in a collection. Children who have not yet mastered cardinality learn to stop at the final number but they do not trust the count and will recount the same collection repeatedly. Mastering cardinality assumes children already have one-to-one correspondence and stable order in their counting.

syntax and a wider range of vocabulary than an everyday conversation, as well as expanding their general knowledge well beyond the everyday. Developing young children's listening comprehension skills well before they can read for themselves enriches their language proficiency and establishes skills they will need to understand texts once they have mastered decoding.

The lower levels of the Sounds and Symbols LP describe simple concepts of print and the early development of phonological awareness. Phonological awareness, which refers to a conscious awareness of the sounds within words, can be developed in preschool children. Caregivers who sing songs or read stories and rhymes that include extensive alliteration can explicitly draw children's attention to the first sounds in words. Singing or reading rhyming verse to children provides opportunities to draw children's attention to end sounds of words. Creating an awareness of sounds in words also enhances children's pronunciation and articulation, which need to be accurate to support the development of phonemic awareness. Children need to be able to hear the difference in the sounds of the 44 phonemes in English in spoken words, as a foundation for learning to read.

The Sounds and Symbols LP also describes the initial development of concepts of print. Reading books to children reinforces simple concepts about print such as its constancy and the way books are organised. Children who grow up in environments where people write labels, lists, notes and text messages, and draw children's attention to what they are doing, as well as pointing out writing in the books they read aloud, show children how writing can be used to express meaning. As children develop phonological and then phonemic awareness and start to become aware of the relationship between the sounds in spoken words and the symbols used to represent them in writing, they are ready to start learning the names and sounds of letters that interest them, and writing some words, ensuring this is now a meaningful activity rather than rote learning.

Early mathematical and scientific language skills

The lower levels of the Mathematics LP describe domain-specific mathematical and scientific language skills and concepts that preschool children can develop in play-based contexts that build on their interests. Children can be encouraged to engage with their world by asking questions, posing problems, making predictions and looking for answers. These questions are the beginnings of mathematical and scientific explorations.

Understanding and using common positional language such as 'up, down, inside and outside' begin in the lowest levels of the LP as children communicate where they want to be. Expanding this language increases children's awareness of, and ability to accurately describe, positions in space including relative positions. At the lowest levels, children notice obvious differences in size. They are small compared with big adults. Expanding and refining their language about size supports children to differentiate aspects of size such as when things are tall or short, fat or thin, far away or close. They begin to learn comparative language that supports the development of an understanding of measurement, initially of length and mass. Children identify which object is longer or shorter, and which is the longest. They can also learn that length does not have to be straight or lying along the ground. They recognise when things are heavy or light: what they can carry and what they cannot even lift, and that small things are sometimes heavier than big things. They also start to observe and describe when containers, such as their cup, are full or empty. They move on to starting to recognise which shape of container is bigger and holds more. This language gradually builds a sound understanding of the concept of volume as they start to understand the difference between comparing the length of objects and how much they hold. Placing flat covers of different sizes over things, such as a cloth on a table or a mat on the floor, and discussing if some, or all, of the table or floor is covered helps to develop an early understanding of the concept of area and how this differs from length. With support, children can learn to use the language of comparison with increasing understanding of the property they are comparing.

The progression in children's conceptual understanding of counting is also described across the lower levels of the Mathematics LP. Learning how to quantify objects is often driven by an early interest in how many things a child has, or is given, and how this compares with what others have. Children quickly learn the counting song, reciting numbers up to 5 or 10. They need to know this sequence but it is rote learning and needs to be accompanied by a great deal of supported practice counting small collections of objects before they really start to understand the concept of quantity and what the count signifies. Children who are encouraged and supported to count quantities, gradually come to understand that 3 is one more than 2, adding one more to 3 makes 4, and adding 2 more makes 5. They slowly start to understand what small numbers mean before progressing to understanding larger numbers, building on a conceptually sound base so that numbers are meaningful.

Young children can learn to look carefully, observe differences and make comparisons that are initially obvious and gradually become more nuanced and discriminating. Having the language to describe the shape and texture of objects heightens awareness and encourages more detailed observations. Are objects round, square, star-shaped, squeaky, soft, hard, flat, smooth, rough, shiny, wet or dry? What are they made of? How do they feel? Which ones are bigger? Can they be rolled, pushed, squashed, slid or lifted, and do they float or not? Children can also be made aware of familiar repeating patterns starting with something simple like the order of a few daily activities and then being supported and encouraged to find other kinds of patterns. These language skills provide the foundation for mathematical and scientific skills and understandings.

Early social and emotional language skills

Everyday oral language communications require simple language skills and understanding of the pragmatics of familiar interactions to participate in and understand how to manage the social and emotional aspects of communication. This progression is described in the initial levels of the domain-general Oral Language LP.

ACER does not yet have an LP for social and emotional skills. Potential domain-specific content is briefly outlined here because there is extensive research evidence of a strong reciprocal relationship between early language skills, social and emotional development, and literacy and mathematics. Domain-specific social and emotional language skills refer to the more nuanced understanding of emotional states and social interactions that young children can start to develop if provided with appropriate modelling, support and encouragement. As children start to develop a wider vocabulary to describe different emotional states their awareness of these states is raised. Greater sensitivity to differences between emotional states and the signs that might indicate these states is promoted. With support, children can also become more skilled in using simple clues, such as tone of voice, to infer the meaning being communicated as well as recognising the importance of checking meaning. Stories can provide opportunities to talk about how characters communicate. Children can be supported to recognise and talk about simple strategies that might be used to facilitate social interactions using their own words. Children can also start to learn about some of the more obvious strategies and pragmatics of social interactions that they do not typically participate in, but might hear about in stories or see on video. These experiences build children's social and emotional language skills and their social and emotional literacy.

Conclusion

Preschool children who are provided with appropriate opportunities and support in play-based contexts, can enrich their general language skills and start to develop domain-specific language skills and conceptual understanding that will provide a sound foundation for their future learning.

References

Blair, C., Ursache, A., Greenberg, M., & Vernon-Feagan, S. L. (2015). FLP Investigators. Multiple aspects of self-regulation uniquely predict mathematics ability in the early elementary grades. *Developmental Psychology, 51*, 459–72.

Blair, C. (2016). Executive function and early childhood education. *Current Opinion in Behavioural Sciences, 10,* 102–107. https://doi.org/10.1016/j.cobeha.2016.05.009.

Beitchman, J., & Brownlie, E. (2010). Language development and its impact on children's psychosocial and emotional development. Rev ed. Rvachew S, topic ed. In R. E. Tremblay, M. Boivin & R. de V. Peters (Eds.). *Encyclopedia on Early Childhood Development* [online]. Centre of Excellence for Early Childhood Development and Strategic Knowledge Cluster on Early Child Development. http://www.child-encyclopedia.com/documents/Beitchman-BrownlieANGxp_rev.pdf.

Castles, A., Rastle, K., & Nation, K. (2018). Ending the reading wars: Reading acquisition from novice to expert. *Psychological Science in the Public Interest, 19*(1), 5–51. https://doi.org/10.1177/1529100618772271

Catts, H. W., Adlof, S., & Ellis-Weismer, S. (2006). Language deficits in poor comprehenders: A case for the simple view of reading. *Journal of Speech, Language, and Hearing Research, 49*, 278–293. https://doi.org/10.1044/1092-4388(2006/023)

Christianson, K. (2016). When language comprehension goes wrong for the right reasons: Good enough, underspecified or shallow language processing. *Quarterly Journal of Experimental Psychology, 69*, 817–828.

Cohen, N. J. (2010). The impact of language development on the psychosocial and emotional development of young children. In R. E. Tremblay, M. Boivin & R. de V. Peters (Eds.). *Encyclopedia on Early Childhood Development* [online]. (2nd ed.) Centre of Excellence for Early Childhood Development and Strategic Knowledge Cluster on Early Child Development; 1–6. http://www.childencyclopedia.com/documents/CohenANGxp.pdf

Corredor, G. A., Justicia-Arráez, A., Romero-López, M., & Benavides-Nieto, A. (2017). Longitudinal study of the effects of social competence on behavioral problems. *Procedia – Social and Behavioural Sciences, 237*, 479–485. https://doi.org/10.1016/j.sbspro.2017.02.093

Dickinson, D. K., Golinkoff, R. M., & Hirsh-Pasek, K. (2010). Speaking out for language: Why language is central to reading development. *Educational Researcher, 39*(4), 305–310. http://dx.doi.org/10.3102/0013189X10370204

Elwér, Å., Gustafson, S., Byrne, B., Olson, R. K., Keenan, J. M., & Samuelsson, S. (2015). A retrospective longitudinal study of cognitive and language skills in poor reading comprehension. *Scandinavian Journal of Psychology, 56*, 157–166. https://doi.org/10.1111/sjop.12188

Fuchs, L. S., Geary, D. C., Compton, D. L., Fuchs, D., Hamlett, C. L., Seethaler, P. M., & Schatschneider, C. (2010). Do different types of school mathematics development depend on different constellations of numerical versus general cognitive abilities? *Developmental Psychology, 46*, 1731-1746. https://doi.org/10.1037/ a0020662

Hart, B., & Risley, T. R. (1995). *Meaningful differences in the everyday experience of young American children*. Paul H. Brookes Publishing Co.

Hecht, S. A., Torgesen, J. K., Wagner, R. K., & Rashotte, C. A. (2001). The relations between phonological processing abilities and emerging individual differences in mathematical computation skills: A longitudinal study from second to fifth grades. *Journal of Experimental Child Psychology, 79*, 192–227. https://doi.org/10.1006/jecp.2000.2586

Hulme, C., Nash, H. M., Gooch, D., Lervåg, A., & Snowling, M. J. (2015). The foundations of literacy development in children at familial risk of dyslexia. *Psychological Science, 26*, 1877–1886. https://doi.org/10.1177/0956797615603702

Kieffer, M. J., Vukovic, R. K., & Berry, D. (2013). Roles of attention shifting and inhibitory control in fourth-grade reading comprehension. *Reading Research Quarterly, 48,* 333–348. https://doi.org/10.1002/rrq.54

Lervåg, A., Hulme, C., & Melby-Lervåg, M. (2017). Unpicking the developmental relationship between oral language skills and reading comprehension: It's simple, but complex. *Child Development, 89*(5), 1821–1838. https://doi.org/10.1111/cdev.12861

Levine, S. C., Suriyakham, L., Rowe, M., & Huttenlocher, J. (2010). What counts in pre-schoolers' development of cardinology knowledge? *Developmental Psychology, 46*(5), 1309–1319. https://doi.org/10.1037/a0019671.

McClelland, M. M., Cameron, C. E., Connor, C. M., Farris, C. L., Jewkes, A. M., & Morrison, F. J. (2007). Links between behavioral regulation and preschoolers' literacy, vocabulary, and math skills. *Developmental Psychology, 43*, 947–959. https://doi.org/10.1037/0012-1649.43.4.947

Miura, I. T., & Okamoto, Y. (2003). Language supports for mathematics understanding and performance. In A. Baroody & A. Dowker (Eds.). *The development of arithmetic concepts and skills: Constructing adaptive expertise* (pp. 229–242). Lawrence Erlbaum.

Mix, K. S. (2008). Surface similarity and label knowledge impact early comparisons. *British Journal of Developmental Psychology, 26*, 13–32.

Mix, K. S., Sandhofer, C. M., & Baroody, A. J. (2005). Number words and number concepts: The interplay of verbal and nonverbal quantification in early childhood. In R. Kail (Ed.). *Advances in child development and behavior* (pp. 305–346). https://doi.org/10.1016/S0065-2407(05)80011-4

Moll, K., Göbel, S. M., Gooch, D., Landerl, K., & Snowling, M. J. (2016). Cognitive risk factors for specific learning disorder: Processing speed, temporal processing, and working memory. *Journal of Learning Disabilities, 49*, 272–281. https://doi.org/10.1177/0022219414547221

Morgan, P. L., Farkas, G., Hillemeier, M. M., Hammer, C.S., & Maczuga, S. (2015). 24-month-old children with larger oral vocabularies display greater academic and behavioral functioning at kindergarten entry. *Child Development, 86*(5), 1351–70. https://doi.org/10.1111/cdev.12398

Morrow, L. M., & Rand, M. K. (1991). Promoting literacy during play by designing early childhood classroom environments. *The Reading Teacher, 44*(6), 396–402.

Nation, K., Cocksey, J., Taylor, J. S. H., & Bishop, D. V. M. (2010). A longitudinal investigation of early reading and language skills in children with poor reading comprehension. *Journal of Child Psychology and Psychiatry, 51*, 1031–39. https://doi.org/10.1111/j.1469-7610.2010.02254.x

Neuman, S. B. (2004). The effect of print rich classroom environments on early literacy growth. *The Reading Teacher, 58*, 89–91.

Purpura, D. J., & Logan, J. A. R. (2015). The non-linear relations between the approximate number system and mathematical language to symbolic mathematics. *Developmental Psychology, 51*, 1717–1724. https://doi.org/10.1037/dev0000055

Rojas, N., M., & Abenavoli, R. M. (2021) Bidirectionality in behavioral regulation, emotional competence, and expressive vocabulary skills: Moderation by preschool social-emotional programs. *Journal of Applied Developmental Psychology, 76*, 101316. https://doi.org/10.1016/j.appdev.2021.101316.

Salmon, K., O'Kearney, R., Reese, E., & Fortune, C. A. (2016). The role of language skill in child psychopathology: implications for intervention in the early years. *Clinical Child & Family Psychology Review, 19*, 352–367. https://doi.org/10.1007/s10567-016-0214-1

Sarama, J., Lange, A. A., Clements, D. H., & Wolfe, C. B. (2012). The impacts of an early mathematics curriculum on oral language and literacy. *Early Childhood Research Quarterly, 27*, 489–502. https://doi.org/10.1016/j.ecresq.2011.12.002

Slot, P. L., Bleses, D., & Jensen, P. (2020). Infants' and toddlers' language, math and socio-emotional development: Evidence for reciprocal relations and differential gender and age effects. *Frontiers in Psychology, 11(*580297). https://doi.org/10.3389/fpsyg.2020.580297

Snow, P. C. (2021). SOLAR: The science of language and reading. *Child Language Teaching and Therapy, 37*(3), 222–233.

Storch, S. A., & Whitehurst, G. J. (2002). Oral language and code-related precursors to reading: Evidence from a longitudinal structural model. *Developmental Psychology, 38*(6), 934–947. https://psycnet.apa.org/doi/10.1037/0012-1649.38.6.934

Vitiello, V., & Williford, A. P. (2016). Relations between social skills and language and literacy outcomes among disruptive preschoolers: Task engagement as a mediator. *Early Childhood Research Quarterly, 36*, 136–144. https://psycnet.apa.org/doi/10.1016/j.ecresq.2015.12.011

Walker, D., Greenwood, C., Hart, B., & Carta, J. (1994). Prediction of school outcomes based on early language production and socioeconomic factors. *Child Development, 65*(2), 606–621.

Welsh, J. A., Nix, R., Bierman, K., Blair, C., & Nelson, K. (2010). The development of executive function and gains in academic school readiness for children in low-income families. *Journal of Educational Psychology, 102*, 43–53.