HHS Public Access

Author manuscript

Child Dev Perspect. Author manuscript; available in PMC 2017 December 01.

Published in final edited form as:

Child Dev Perspect. 2016 December ; 10(4): 269–274. doi:10.1111/cdep.12200.

A Lattice Model of the Development of Reading Comprehension

Carol McDonald Connor

University of California Irvine

Abstract

In this article, I present a developmental model of how children learn to comprehend what they read, which builds on current models of reading comprehension and integrates findings from instructional research and evidence-based models of development in early and middle childhood. The lattice model holds that children's developing reading comprehension is a function of the interacting, reciprocal, and bootstrapping effects of developing text-specific, linguistic, and social-cognitive processes, which interact with instruction as child-characteristic-by-instruction (CXI) interaction effects. The processes develop over time and in the context of classroom, home, peer, community, and other influences to affect children's development of proficient reading comprehension. I first describe models of reading comprehension. I then review the basic processes in the model, the role of instruction, and CXI interactions in the context of the lattice model. I then discuss implications for instruction and research.

Keywords

Reading; Literacy; Cognition; Language; Self-regulation; Instruction

Proficient reading comprehension is critical in today's information-based world. Children who fail to develop proficient literacy skills are disadvantaged in school and throughout their lives. Over the past decades, researchers have linked language skills, social cognition, instruction, and literacy skills. Weaker language and social-cognitive development, as well as ineffective instruction, are almost always associated with weaker development of literacy. My colleagues and I have suggested that a more dynamic model of reading comprehension might help explain how children learn to understand what they read, and inform more effective instructional programs, particularly for children in poverty (1, 2). We have conceptualized reading comprehension as a

> complex activity that requires the reader … to call on the coordination of cognitive, regulatory, linguistic, and text-specific processes, including decoding [and encoding] of text, which are developing over time and that have reciprocal and interacting bootstrapping effects on one another. (1, p. 2)

We refer to this conceptual framework as the *lattice model* because these interacting effects can be depicted as a lattice. Figure 1 presents our current conceptualization of the lattice

Correspondence concerning this article should be addressed to Carol McDonald Connor, connorcm@uci.edu.; University of California, Irvine, School of Education, Irvine, CA 92697.

model, which has expanded to include social aspects of cognition and how instruction fits within our conceptualization.

The model brings together several useful models of child development and reading comprehension, and hypothesizes how text-specific, linguistic, and social-cognitive processes influence and are influenced by learning to read text with comprehension. These processes are malleable but respond to environmental influences to differing degrees and may be more malleable earlier in childhood than later (e.g., language). Within this model, instruction—at school and at home—directly and indirectly affects the processes and children's ability to learn how to comprehend when reading (2). Following dynamic systems models (3), the lattice model is part of a larger system, with systems within systems that affect one another. Consistent with bio-ecological theory (4), the lattice model recognizes the importance of more distal influences on the system (e.g., local policies), but these influences are assumed to operate indirectly through peers, parenting and teaching. Children develop physically, linguistically, socially, cognitively, and emotionally during early and middle childhood, which also influences learning and effective instruction. The lattice model attempts to understand the processes and influences that affect the development of reading comprehension while recognizing the complexity of the systems overall. In this article, I discuss each of the processes in the lattice model: text-specific processes, linguistic processes, and social-cognitive processes. I also touch on the role of instruction and development as elements of the lattice model; I then discuss evidence supporting the lattice model. I conclude with implications for theory and practice.

Key Elements of the Lattice Model

Text-Specific Processes and Models of Reading Comprehension

Text-specific processes are processes imposed by writing and reading what is written, including orthographic knowledge, decoding, encoding (spelling), word and text fluency (automaticity), text structure, and other skills specific to reading and writing written language. These processes exist only because we read and write. Unlike language, which has evolved in humans over many millennia (5), reading was invented by humans about 5000 years ago (6). Oral language is translated into written language in several ways. English uses an alphabetic system of writing. Thus, when learning to read and write English, children master the alphabetic principle: that letters stand for phonemes, which can be blended together to form meaningful words (7). Written systems do not map directly onto conversational speech; they tend to be more formal, use unfamiliar vocabulary and grammar, and use conventions to help the reader understand.

According to current definitions of reading comprehension, when students read with discernment, they build a coherent mental representation of the meaning of the text (8), also called a situation model (9). As they read, students set standards of coherence based on the purpose for reading and the difficulty of the text. For example, standards of coherence may be low when children read a book for fun and high when they read to learn. The students' purpose and motive for reading the text (a social-cognitive process) may influence how much they read, how well they monitor their comprehension, and the extent to which they make inferences (10–12).

The Lexical Hypothesis model (13) informs many of the underlying premises of the lattice model, such as reciprocal effects. It demonstrates that, within the linguistic and text-specific systems, the linguistic system (phonology, syntax, morphology) informs the text-specific system (letter-sound associations). Word identification is defined by reciprocal effects between text-specific processes and the lexicon. In turn, the lexicon is associated reciprocally (through meaning, morphology, and syntax) with comprehension processes (parser, text representation, inferences, and situation model). General knowledge (which the lattice model includes as a linguistic process) informs the lexical and comprehension processes and, reciprocally, comprehension processes predict general knowledge. Although it is one of the most useful and well-supported models, the Lexical Hypothesis model lacks a developmental perspective and does not address how distal and proximal influences, including instruction, influence this system or the components within it. The lattice model addresses these elements.

Linguistic Processes

Components of language include phonology, morphology, lexicon, semantics, and pragmatics (14). However, at least in early and middle childhood, researchers cannot distinguish these components among typically developing children (15). Rather, two distinct constructs appear to exist: the lexical system, specifically word knowledge and use, and more complex aspects of the linguistic system, including semantics (understanding and expressing meaning), syntax (grammar), morphology, and oral comprehension. Although these two components may be distinct statistically, they are related. Additionally, academic knowledge is apparently an integral part of linguistic processes, likely as part of the semantic system (2). In the lattice model, we conceptualize language and knowledge as a system of linguistic processes rather than as discrete components.

During the years children learn to read, from their early interactions with books to independent reading and writing, language develops from jargon to complete complex sentences and conversations. The development of language influences the development of literacy (16). The lattice model also assumes reciprocal effects, and that learning to read and the acts that accompany literacy (e.g., parents reading to their children) support the development of more literate or academic language that is used in textbooks and when writing (17).

Social-Emotional and Cognitive Processes

In the lattice model, we bring together several separate bodies of work that examine volitional or regulatory processes involved in learning. Effortful control (18), executive functioning (19), self-regulation (20–22) learning-related social skills, (23), motivation and goal orientation (24), as well as metacognition (25, 26), work together as an integrated albeit complex system.

One might argue that metacognition and executive function are domain-general processes (27). In thinking about the lattice model, we strive to be more precise in our terminology while observing that social-emotional and cognitive processes are related. Eisenberg and colleagues note that effortful control and executive functioning “include an array of

processes or capabilities that can be used to manage emotion and behavior" (18, p. 158). And as we studied the role of these regulatory processes, we decided to consider students' management of learning within the challenging cognitive and social environment of the classroom. In this article, I focus on social-cognitive regulatory processes related to learning, including self-regulation, motivation and goal orientation, and metacognition, keeping in mind that other processes are influential, such as emotion regulation (18), the influences of peers (28), and functioning in the classroom environment.

Self-regulation—the coordination of executive functioning, effortful control, and self-regulated learning (18, 20–22)—includes processes that support purposeful and flexible adaptation to the environment, and are associated with success with complex and cognitively challenging tasks, such as learning to read. Students with strong self-regulation can pay attention, remember and follow directions, persist, and switch flexibly between tasks. Self-regulation is associated with early literacy and development of vocabulary (21). Self-regulated learning (29) calls on the social-emotional constructs of persistence and motivation (11), as well as on the social-cognitive processes of effortful control, attention, and working memory (22).

Motivation is related to reading success in childhood and adolescence (24). Children's motivation to complete a task is a function of how much they value the task, their perception of their competency, and their goal orientation. Children's perception of competency becomes more accurate as they mature (young children assume they are very competent), which has implications for motivation and learning. Literacy interventions that improve motivation, such as allowing students control over content, have led to stronger reading skills (30). At the same time, proficient reading skills can support stronger motivation.

Metacognition is thinking about thinking, and includes the ability to evaluate and then regulate mental operations (31). Metacognition takes many forms, all of which share two features: the conscious awareness of the cognitive process or mental operation, and the potential to regulate or manipulate the cognitive process. Key to the lattice model is that metacognition develops throughout early and middle childhood, though some argue that full cognitive awareness does not emerge until about age 8 years or second grade (31). Monitoring comprehension, a metacognitive skill, is apparently essential to proficient reading for understanding (26). When students monitor their comprehension, they recognize that text does not make sense and use strategies, such as rereading or self-questioning (e.g., "what is the author trying to say?"), to make inferences and repair their understanding to develop a coherent mental representation. In a study that tracked fifth graders' eye movements (32), students identified aspects of text that did not make sense but differed in the extent to which they attempted to repair their misunderstanding. Students with weaker academic language skills generally spent less time rereading and trying to repair their understanding of words that did not make sense than did students with stronger language skills.

Researchers studying social emotion and cognitive regulation have proposed reciprocal effects among the constructs (e.g., effortful control is related reciprocally and overlaps with executive functioning; 18), but most assume that these regulatory processes subserve

learning to read and proficient reading for understanding. In the lattice model, we hypothesize that these social-cognitive regulatory processes are also strengthened by learning to read and write. Learning and instruction occur in the socially and cognitively challenging environment of the classroom, which can provide rich learning opportunities not only for text-specific and linguistic processes, but for regulatory processes as well.

Instruction

Children must be taught reading and writing and they must practice these skills to acquire them and gain expertise. However, the effect of instruction apparently depends on the text-specific, linguistic, and social-cognitive skills children bring to the classroom. The development of reading comprehension features CXI interaction effects (33). When literacy instruction is matched to students' language and reading skills, they make greater gains (34). Teachers used flexible learning groups during the literacy block based on the children's reading skills. The accumulation of effects supports the lattice model, reciprocal effects, and the impact of individualizing instruction in developing literacy (34). Students in treatment classrooms all three years made significantly greater gains compared to students in treatment classrooms for fewer years or who were only in control classrooms; individualized instruction built on students' improving skills.

Testing the Lattice Model

The lattice model assumes that there are reciprocal effects and that these effects happen in the context of children's development and the instruction they receive. Text-specific, linguistic, and social-cognitive processes work together to support the development of literacy in the context of instruction. Literacy development, in turn, supports the development of these processes. Additionally, the characteristics (linguistic, social-cognitive) and text-specific skills children bring to the classroom influence the instruction they receive and their response to this instruction (CXI interactions).

Studies finding reciprocal effects support the lattice conceptual model, specifically that gains in reading comprehension predict gains in linguistic and social-cognitive processes. Learning literacy may speed access to semantic categories (35). Longitudinal studies also suggest that reciprocal effects between language and reading emerge between ages 7 and 8 years (36). Early reading comprehension skills predict later vocabulary gains (37). Children who develop stronger reading skills in first grade are more likely to become avid readers through elementary school and to be more motivated to read; they may also have stronger cognitive skills, as well as vocabulary and general knowledge, by high school (38).

The lattice model is unique because it includes literacy instruction and supports not only gains in reading comprehension but linguistic and social-cognitive processes. The lattice model is further supported by a study of first graders (39) in which more individualized early reading instruction led to stronger gains in self-regulation. In that study, from the start to the end of the school year, students in the treatment group gained more in both literacy and self-regulation skills. Professional development to improve classroom organization and greater expectations for students' self-regulated learning in the treatment classrooms led to greater gains in self-regulation, particularly for students who started the year with weaker self-

regulation. According to the lattice model, greater gains in reading skills also may have contributed to greater gains in self-regulation.

To test the lattice model, we examined the predicted simultaneous reciprocal effects in the context of instruction from first through second grade (2). Specifically, in a longitudinal study, we examined reciprocal effects of text-specific processes (word reading and reading comprehension), linguistic processes (vocabulary and academic knowledge), and social-cognitive processes (self-regulation, attention, working memory, and task inhibition-switching). Surprisingly, linguistic regulatory processes were not associated directly with social-cognitive regulatory processes but were associated indirectly through their relation with text-specific processes. Text-specific and linguistic processes were reciprocally related, as were text-specific and social-cognitive regulatory processes. Moreover, more effective and individualized literacy instruction changed associations among the processes and decreased the stability of reading over time. Taken together, these findings provide preliminary support for the lattice model.

The lattice model offers several mechanisms that may help explain these findings. Children are exposed to academic words and complex grammar through print (including digital text) that is not used in conversations (10, 16). Furthermore, instruction in the elementary grades is more formal than instruction in preschool and at home. Learning to read is difficult and requires persistence, motivation, and attention. This change in the structure of instruction may support developing social-cognitive processes, as well as reading comprehension and language development. More malleable learned skills, such as text-specific processes, might bootstrap less malleable skills, such as working memory (40). Additionally, changes to the brain that occur as children learn to read might also strengthen linguistic and social-cognitive processes reciprocally (41).

Summary

In the United States and worldwide, educators are working to improve all students' development of literacy amid the challenges of a global and highly complex world. Too many children fail to attain proficient reading comprehension skills, particularly children in poverty (42). One reason for this may be an underappreciation of CXI interactions and the complexity of the interacting skills and aptitudes required to learn how to read with full and deep understanding. With the lattice model, we present a more complex conceptual framework based on theories of reading and learning, integrated with early and middle childhood theories of development, including bio-ecological and dynamic systems models. The lattice model hypothesizes that learning to read, in the context of instruction, supports developing linguistic and social-cognitive processes, which in turn support developing text-specific processes, and that these work together to support reading comprehension, reciprocally, throughout early and middle childhood.

A key assumption is that instruction, at school and at home, is a critical part of learning to read and is more effective when it considers individual differences in children. The lattice model moves away from one-size-fits-all and one-way component interventions (e.g., improving self-regulation to improve comprehension) and toward instructional models that

take advantage of reciprocal and bootstrapping effects, and the effects of literacy instruction that are conjectured. Focusing on effectively teaching young children to decode and understand the text they read to improve their reading comprehension, while strengthening their vocabulary and oral language skills, should also improve children's linguistic and social-cognitive regulatory skills over time and, in turn, further support developing reading comprehension skills. Indeed, pushing the reciprocal loop in the positive direction for language, vocabulary, and literacy development can help children who are socioeconomically disadvantaged and at risk for developing weaker social-cognitive regulation. Thus, effective literacy instructional programs should be comprehensive and consist of many components, use well-developed and evidence-based standards of practice, and consider differences in students by individualizing or personalizing instruction. Understanding more fully the complexity of reading comprehension and how difficult it is to teach and learn can inform research, improve models of literacy, advance the development of effective instructional practices, and promote academic success for all students.

Acknowledgments

I thank my colleagues Beth Phillips, Christopher Lonigan, and Frederick J. Morrison, the entire ISI team, and members of the IES Reading for Understanding Network with whom I have discussed many of the ideas in this article. I also thank Stephanie Day for reading a draft of this article. Funding for my research and writing this article was provided by the U.S. Department of Education, Institute of Education Sciences, R305F100027, R305H04013, R305A130058, and R305B070074, and the Eunice Kennedy Shriver National Institute of Child Health and Human Development, R01HD48539 and P50 HD052120. These views are my own and not those of the funding agencies.

References

1. Connor CM, Phillips B, Kaschak M, Apel K, Kim Y-S, Al Otaiba S, Lonigan C. Comprehension tools for teachers: Reading for understanding from prekindergarten through fourth grade. Educational Psychology Review. 2014; 26:379–401. [PubMed: 26500420]
2. Connor CM, Day SL, Phillips B, Sparapani N, Ingebrand SW, McLean L, Kaschak MP. Reciprocal Effects of Self-Regulation, Semantic Knowledge, and Reading Comprehension in Early Elementary School. Child Development. 2016 n/a-n/a.
3. Mitchell, M. Complexity: A guided tour (Vol. Kindle Edition). New York, NY: Oxford Press; 2011.
4. Bronfenbrenner, U.; Morris, PA. The bioecological model of human development. In: Lerner, RM.; Damon, W., editors. Handbook of child psychology: Theoretical models of human development. 6th. Vol. 1. Hoboken, NJ: John Wiley & Sons; 2006. p. 793-828.
5. Dunbar, R. Grooming, gossip, and the evolution of language. Cambridge, MA: Harvard University Press; 1996.
6. Daniels, PT.; Bright, W., editors. The world's writing systems. Oxford, UK: Oxford University Press; 1996.
7. Ehri, LC. Phases of acquisition in learning to read words and implications for teaching. In: Stainthorp, R.; Tomlinson, P., editors. Learning and teaching reading. London, UK: British Journal of Educational Psychology Monograph Series II; 2002. p. 7-28.
8. Rapp DN, van den Broek P, McMaster K, Kendeou P, Espin CA. Higher-order comprehension processes in struggling readers: A perspective for research and intervention. Scientific Studies of Reading. 2007; 11:389–312.
9. Kintsch, W. Comprehension: A paradigm for cognition. New York, NY: Cambridge Unviersity Press; 1998.
10. Cain K, Oakhill J, Lemmon K. Individual differences in the inference of word meanings from context: The influence of reading comprehension, vocabulary knowledge, and memory capacity. Journal of Educational Psychology. 2004; 96:671–681. doi: http://dx.doi.org/10.1037/0022-0663.96.4.671.

11. Wigfield A, Guthrie JT. Relations of children's motivation for reading to the amount and breadth of their reading. Journal of Educational Psychology. 1997; 89:420–432. doi: http://dx.doi.org/10.1037/0022-0663.89.3.420.
12. Snow, CE. Reading for understanding. Santa Monica, CA: RAND Education and the Science and Technology Policy Institute; 2001.
13. Perfetti C, Stafura J. Word knowledge in a theory of reading comprehension. Scientific Studies of Reading. 2014; 18:22–37.
14. American Speech-Language-Hearing Association. Language. 2015. Retrieved August 2016 from http://www.asha.org/policy/rp1982-00125.htm
15. Language and Reading Research Consortium. The Dimensionality of Language Ability in Young Children. Child Development. 2015; 86(6):1948–1965. [PubMed: 26509742]
16. Dickinson DK, Porche MV. Relation between language experiences in preschool classrooms and children's kindergarten and fourth-grade language and reading abilities. Child Development. 2011; 82:870–886. [PubMed: 21413936]
17. Snow CE. Academic language and the challenge of reading for learning about science. Science. 2010; 328:450–452. [PubMed: 20413488]
18. Eisenberg, N.; Hofer, C.; Sulik, MJ.; Spinrad, TL. Self-regulation, effortful control, and their socioemotional correlates. In: Gross, JJ., editor. Handbook of emotion regulation. New York, NY: Guilford; 2014. p. 157-172.
19. Dunning DL, Holmes J, Gathercole SE. Does working memory training lead to generalized improvements in children with low working memory? A randomized controlled trial. Developmental Science. 2013; 16:915–925. [PubMed: 24093880]
20. McClelland MM, Morrison FJ. The emergence of learning-related social skills in preschool children. Early Childhood Research Review Quarterly. 2003; 18:206–224.
21. Lin, B.; Coburn, SS.; Eisenberg, N. Self-regulation and reading achievment. In: Connor, CM., editor. The cognitive development of reading and reading comprehension. New York: Routledge; 2016. p. 67-86.
22. Zimmerman, BJ. Dimensions of academic self-regulation: A conceptual framework for education. In: Zimmerman, BJ.; Schunk, DH., editors. Self-regulation of learning and performance. Hillsdale, NJ: Erlbaum; 1994. p. 3-24.
23. McClelland MM, Morrison FJ, Holmes DL. Children at risk for early academic problems: The role of learning-related social skills. Early Childhood Research Quarterly. 2000; 15:307–329.
24. Wigfield, A.; Eccles, JS. The development of competence beliefs, expectancies for success, and achievement values from childhood through adolescence. In: Wigfield, A.; Eccles, JS., editors. Develoment of achievement motivation. New York, NY: Academic Press; 2002. p. 92-96.
25. Silva M, Cain K. The relations between lower and higher level comprehension skills and their role in prediction of early reading comprehension. Journal of Educational Psychology. 2015; 107:321–331.
26. Kinnunen, R.; Vauras, M. Tracking online metacognition: Monitoring and regulating comprehension in reading. In: Efklides, A.; Misailidi, P., editors. Trends and prospects in metacognition research. New York, NY: Spring; 2010. p. 209-258.
27. Melby-Lervag M, Lervag A. Effecs of educational interventions targeting reading comprehension and underlying components. Child Development Perspectives. 2014; 8:96–100.
28. Justice LM, Petscher Y, Schatschneider C, Mashburn A. Peer effects in preschool classrooms: Is children's language growth associated with their classmates' skills. Child Development. 2011; 82:1768–1777. [PubMed: 22026480]
29. Harris KR, Graham S, Mason LH. Improving the writing, knowledge, and motivation of struggling young writers: Effects of self-regulated strategy development with and without peer support. American Educational Research Journal. 2006; 43:295–340.
30. Guthrie JT, McRae A, Klauda SL. Contributions of concept-oriented reading instruction to knowledge about interventions for motivations in reading. Educational Psychologist. 2007; 42:237–250.
31. Efklides, A.; Misailidi, P. Trends and prospects in metacognition research. New York, NY: Springer; 2010.

32. Connor CM, Radach R, Vorstius C, Day SL, McLean L, Morrison FJ. Individual differences in fifth graders' literacy and academic language predict comprehension monitoring development: An eye-movement study. Scientific Studies of Reading. 2015; 19:114–134. [PubMed: 27065721]
33. Cronbach, LJ.; Snow, RE. Aptitudes and instructional methods: A handbook for research on interactions. New York, NY: Irvington; 1977.
34. Connor CM, Morrison FJ, Fishman B, Crowe EC, Al Otaiba S, Schatschneider C. A longitudinal cluster-randomized controlled study on the accumulating effects of individualized literacy instruction on students' reading from first through third grade. Psychological Science. 2013; 24:1408–1419. [PubMed: 23785038]
35. Kolinsky R, Monteiro-Plantin RS, Mengarda EJ, Grimm-Cabral L, Scliar-Cabral L, Morais J. How formal education and literacy impact on the content and structure of semantic categories. Trends in Neuroscience and Education. 2014; 3:106–121. doi: http://dx.doi.org/10.1016/j.tine.2014.08.001.
36. Verhoeven L, van Leeuwe J, Vermeer A. Vocabulary growth and reading development across the elementary school years. Scientific Studies of Reading. 2011; 15:8–25.
37. Cain, Kate; Oakhill, Jane. Matthew Effects in Young Readers: Reading Comprehension and Reading Experience Aid Vocabulary Development. Journal of Learning Disabilities. 2011; 44:431–443. [PubMed: 21772058]
38. Cunningham AE, Stanovich KE. Early reading acquisition and its relation to reading experience and ability 10 years later. Developmental Psychology. 1997; 33:934–945. [PubMed: 9383616]
39. Connor CM, Ponitz CEC, Phillips B, Travis QM, Day SG, Morrison FJ. First graders' literacy and self-regulation gains: The effect of individualizing instruction. Journal of School Psychology. 2010; 48:433–455. [PubMed: 20728691]
40. Melby-Lervag M, Hulme C. Is working memory training effective? A meta-analytic review. Developmental Pscyhology. 2012; 49:270–291.
41. Simos PG, Fletcher JM, Sarkari S, Billingsley RL, Denton C, Papanicolaou AC. Altering the brain circuits for reading through intervention: A magnetic source imaging study. Neuropsychology. 2007; 21:485–496. doi: http://dx.doi.org/10.1037/0894-4105.21.4.485. [PubMed: 17605581]
42. National Assessment of Educational Progress (NAEP). National Assessment of Educational Progress: The nation's report card. Washington DC: National Center for Education Statistics; 2015. http://www.nationsreportcard.gov/reading_math_2015/#reading?grade=4, retrieved August 2016

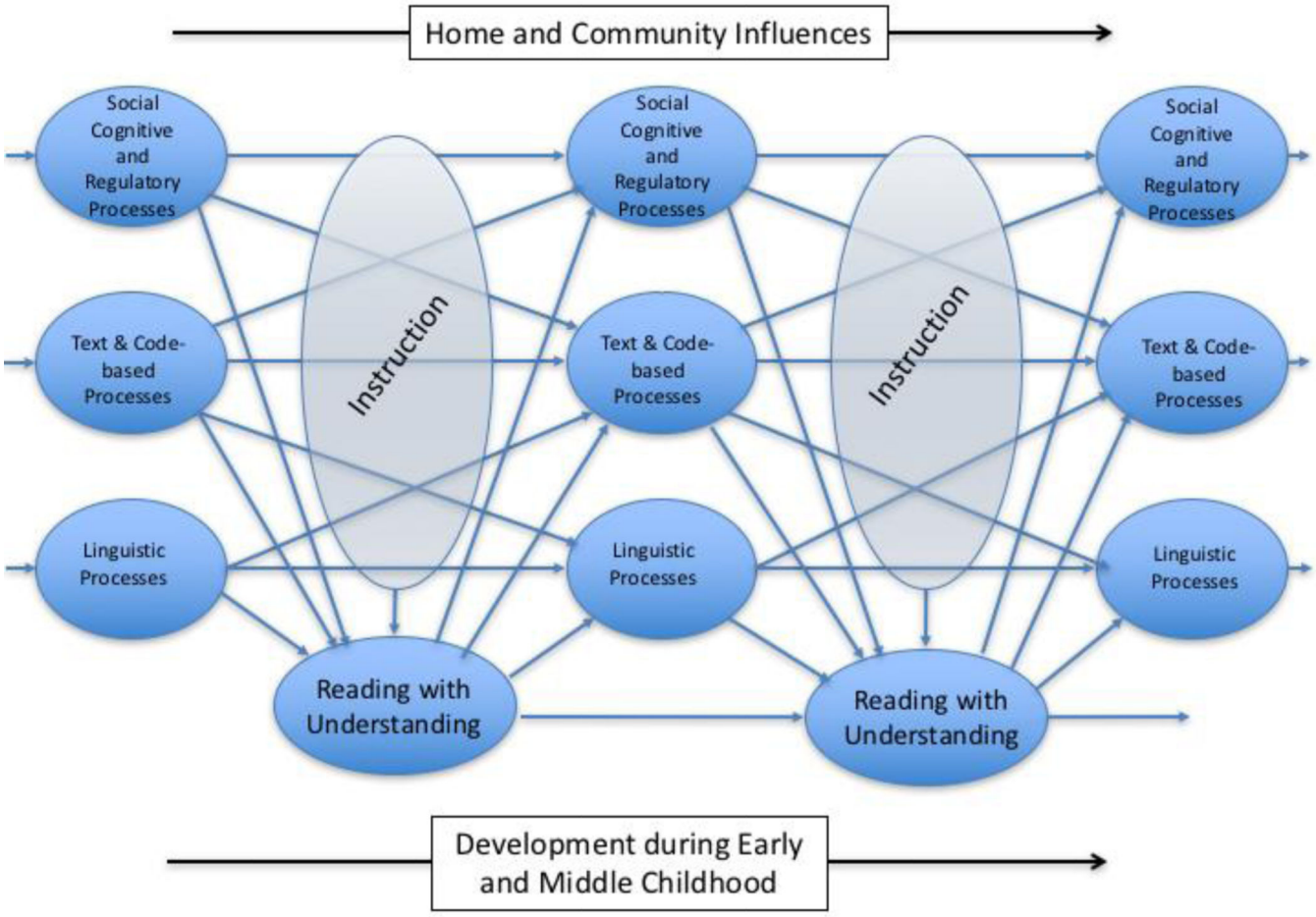

Figure 1.

Current conceptualization of the lattice model, where developing and reciprocal effects of linguistic, text-specific, and social-cognitive processes, and the socially and cognitively challenging learning environment of the classroom, interact and support children's learning to read with understanding. In turn, developing reading comprehension supports children's development of linguistic, social-cognitive, and text-specific processes, which should influence teachers' decisions about providing the individualized instruction students receive.