Children's Peer Cooperative Problem Solving During Play in Preschool

A Systematic Literature Review

Meilan Jin

The author reviews the literature concerning cooperative problem solving (CPS), the process in which two or more children collaborate by sharing perspectives and exploring new ways to tackle common problems. The review considers the definitions and measurements of CPS and various examinations of its relationship to play and other factors such as surrounding conditions, age, sex, and ability. Her findings reveal the complexity of CPS, which involves both verbal actions and nonverbal behaviors and varies according to the conditions of play, as well as children's ages, sex, and individual abilities. She also finds a significant positive relationship between CPS-associated behaviors and play. **Key words**: comparative studies in play, cooperative problem solving, early childhood and play

Introduction

Studying the development of children's cooperative problem solving (CPS) during play proves particularly valuable in the twenty-first century. Children growing up in a global society encounter problems that are relevant to diverse cultures rather than being confined to specific groups. We often view CPS as a process in which two or more children collaborate, by coordinating their perspectives and exploring new ways to address shared challenges (Ashley and Tomasello 1998). This process not only enhances social interaction among children but also enables them to acquire new skills, knowledge, and dispositions (Rogoff and Morelli 1997; Rubin et al. 2006).

Children's engagement in CPS during play proves theoretically valuable because play provides a pathway to construct their knowledge (Piaget 1951) and develop problem-solving skills through interactions with more advanced peers (Vygotsky 1978). We often hear that "play leads development" because children

American Journal of Play, volume 18, number 1
Contact Meilan Jin at jinm2@wwu.edu

strive to stay engaged in play episodes, even when faced with challenges, in order to remain part of the learning group (Bodrova and Leong 2007). This effort to engage with others during play encourages children to exhibit more advanced behaviors—sometimes standing "a head taller" than what is typical for them (Vygotsky 1978, 102).

The Relationship Between CPS and Play Contexts

Both cognitive development theory and sociocultural theory emphasize that children are free to explore their psychological desires through play. Piaget (1983) described play as enabling children to gain a sense of control over themselves and their environments, facilitating problem solving and the mastery of new skills. In particular, play materials serve as mediational tools that help children learn language, develop problem-solving skills, and engage in social interactions (Piaget 1951).

Vygotsky (1978) viewed play as both a source and a context for development in which children continue to learn within their zones of proximal development (ZPDs). He defined ZPDs as the "distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (86). Vygotsky argued that, in play contexts, children have opportunities to engage socially with advanced peers, which enhances their ability to tackle complex problems, internalize skills learned from interactions, and apply new knowledge to future challenges.

The positive relationship—both theoretically and practically—between CPS and play is well documented. However, we still need systematic research conducted in daily contexts to explore their in-depth relationship. Much of the existing research on the CPS of preschoolers and its connection to play has relied on experimental methods. Yet, children's play takes place within social contexts that differ significantly from controlled experimental settings (Rogoff and Morelli 1997). Preschool-aged children spend a substantial amount of time in school, engaging in various types of play in classroom environments. This play is influenced by the social contexts of the classroom, which are shaped by the beliefs and practices of teachers and the educational institution (VanHoorn et al. 2011). These beliefs can lead to differences in classroom decision making, resulting in diverse settings, materials, and time allocations for children's indoor

play (Cuffaro 1995; Dewey 1902, 1997). Therefore, it is likely that children's CPS during play in everyday classroom settings reflects these variations.

Review Purpose

Although CPS has been extensively studied in older children and adults, research focusing specifically on preschool-aged children remains limited. This gap is significant because early childhood is a critical period for the development of foundational social, cognitive, and collaborative skills. Gaining a deeper understanding of how young children engage in CPS during play can contribute meaningfully to both developmental theory and early educational practice.

Furthermore, much of the existing research on CPS in young children has taken place in controlled experimental settings, which may not fully reflect the complexity and nuance of children's collaborative behaviors in everyday learning environments. This review therefore places particular emphasis on studies conducted in naturalistic settings—such as preschool classrooms and play-based contexts—to capture better how CPS unfolds in real-world early childhood education.

By synthesizing current findings, this review aims to identify key patterns, highlight methodological and conceptual gaps, and propose directions for future research that can inform both theory and practice. This analysis addresses the following research questions: How has cooperative problem solving (CPS) been defined and measured in studies involving preschool children? What is the relationship between CPS and play in preschool contexts? How do factors such as age, sex, and ability influence CPS behaviors during play?

Method

Literature Search

A systematic literature search was conducted in accordance with PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analyses) guidelines using three databases: ERIC, PsycInfo, and Web of Science. Search terms combined: "cooperative problem solving," "play," "preschool," "children," and "collaborative problem solving." To capture the full scope of relevant literature on children's CPS during play—particularly studies conducted in naturalistic

settings—the publication date filter was set to "all time." This decision allowed the inclusion of both recent and earlier foundational studies. The search was completed on September 9, 2022, and included all relevant articles published prior to that date, yielding a total of 1,639 records for initial screening.

Inclusion Criteria of Publication

Duplicates (n = 587) were removed from the search results first, leaving 1,052 papers for screening. The screening process consisted of reading the abstracts first and then reading the full texts. I followed the inclusion and exclusion criteria (see figure 1) to identify articles that met all desired criteria. To ensure reliability, my research assistant and I independently screened the papers using the inclusion criteria, achieving 100 percent agreement on screening. After this process, fourteen articles remained for full-text review.

One of the purposes of this systematic review is to understand the nature of peer CPS and the relationship between peer CPS and play in preschool contexts. Therefore, I excluded studies that focused on teacher-child or care giver–child interactions influencing children's development of CPS, the impact of technology-mediated environment on children's CPS learning, or the mental health impacts of care givers or teachers. I also excluded studies addressing

	IN	OUT
Topic Focus	Studies focus on children's peer cooperative /collaborative problem solving during play	Studies focus on (1) technology-mediated collaboration, (2) teacher-child interaction (3) caregiver-child interaction, (4) mental health impacts of caregivers/teachers on children's CPS, and (5) emotional regulation during conflict resolution.
Age	3 - 5 years; typical development	Infant/toddler; age 6 and onwards; atypical development
Language of Manuscript	English	Non-English
Research Design	Empirical research	systematic reviews, meta-analyses, research reports, and opinion papers
Publication Type	Peer-reviewed articles	Master's thesis and doctoral dissertations

Figure 1. Inclusion and exclusion criteria

solely children's emotional regulation during conflict resolution, because they did not specifically focus on children's CPS.

This review targeted preschool-aged, typically developing children. Thus, I excluded studies involving participants beyond this age range or atypically developing children. However, I retained for analysis studies meeting both inclusion and exclusion criteria. For example, I included a study involving both preschoolers and older children if it had relevant findings about the targeted population. Overall, I reviewed fourteen articles at the full-text level, resulting in the exclusion of five articles, leaving nine articles for analysis.

Final Extraction

To conduct a thorough search for studies focusing on children's CPS during play in preschool, I reviewed the reference lists of the nine included articles. By examining the titles, abstracts, and full texts of these references, I identified an additional nine articles that met all inclusion criteria. This increased the total number of articles retained for further analysis to eighteen (see figure 2).

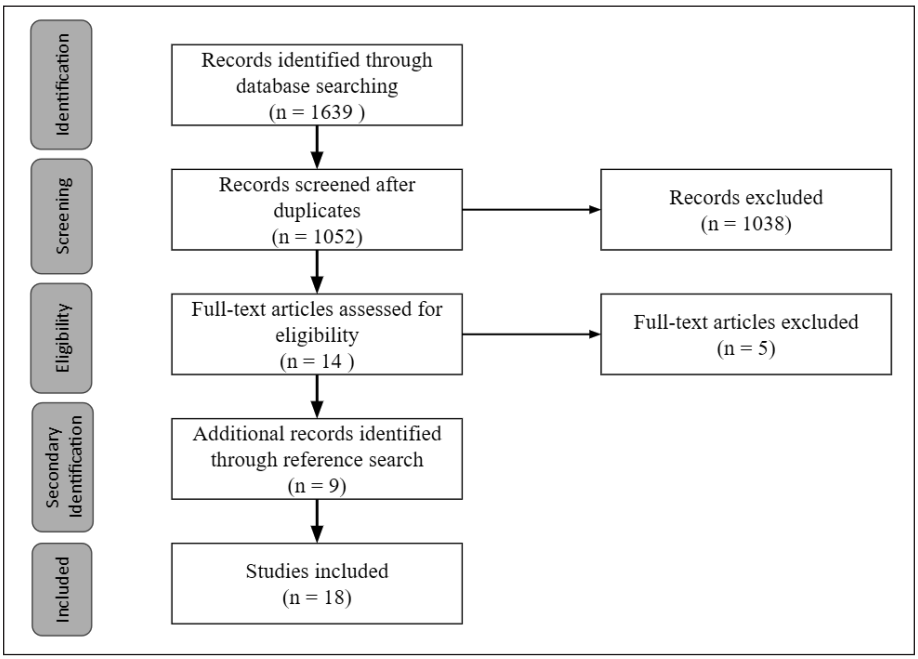

Figure 2. Article selection process

Articles	CPS Terms			Types of Play		CPS Evaluation			Methodology		
	Cooperative Problem Solving	Collaborative Problem Solving	Other Names	Child-Led Free Play	Adult-Directed/ Designed Play	Child Performance	Environmental Input		Quantitative	Qualitative	Mixed Method
							Experimental Setting	Non-Experimental Setting			
Arterberry, et al. (2007)			x		x	x	x		x		
Ashley & Tomasello (1998)	x				x	x	x		x		
Azmitia (1988)		x			x	x	x		x		
Cannella (1993)			x		x	x	x		x		
Charlesworth & Dzur (1987)			x		x	x	x		x		
Cooper (1980)		x			x	x	x		x		
Domberg et al. (2021)		x			x	x	x		x		
Duran & Gauvain (1993)			x		x	x	x		x		
Garton & Pratt (2001)		x			x	x	x		x		
Gauvain & Rogoff (1989)			x		x	x	x		x		
Hamann et al. (2012)			x		x	x	x		x		

Figure 3. Overview of eighteen studies

Holmes-Lonergan (2003)		x		x	x	x		x
Koymen & Tomasello (2018)			x	x	x	x		x
Mugny & Doise (1978)			x	x	x	x		x
Muller & Perlmutter (1985)			x	x	x	x	x	x
Ramani (2012)	x			x	x	x		x
Tudge (1992)			x	x	x	x		x
Warneken et al. (2014)		x		x	x	x		x

Figure 3. Overview of eighteen studies, (continued)

Terms/ Articles	Definitions
CPS	
Ashley & Tomasello (1998)	Two children must cooperate in order to solve an external problem
Ramani (2012)	Two children work together to solve an external goal
Collaborative Problem Solving	
Azmitia (1988)	NA
Cooper (1980)	Mutual coordination of action by two children toward the achievement of a common goal
Domberg et al. (2021)	Communicating and evaluating reasons provided by the individuals working together
Garton & Pratt (2001)	Inter-subjectivity occurs when the two participants share the same task, or situation definition, and each knows the other shares the same definition. [...] Thus in collaborative problem solving, the child is guided and supported to accomplish the solution and he/she learns how to achieve mutuality and inter-subjectivity, each of which is instrumental to task success.
Holmes-Lonergan (2003)	Working together to solve problems
Warneken et al. (2014)	Simultaneous coordination of several different behavioral and social-cognitive skills
Other Names	
Arterberry, et al. (2007)	**Cooperation** is providing help or working together with actions such as showing, pointing, and encouragement
Charlesworth & Dzur (1987)	**Cooperation**: NA
Duran & Gauvain (1993)	**Peer collaboration** facilitates learning because partners often contribute new information, define and restructure a problem in a way that is familiar, and generate discussions that lead to the selection of the most effective problem-solving strategy
Gauvain & Rogoff (1989)	**Team collaboration** is the effort to manage the team member's roles as well as the actual sharing of decision-making for each task.
Hamann et al. (2012)	**Joint action** is when two or more individuals work together toward some mutual benefit
Koymen & Tomasello (2018)	**Interactive context** is that two peers would need to jointly solve a problem to reach correct joint decisions for a reward and investigate whether/how they produced meta-talk, explanations about the information source, and the information reliability, for their decisions.
Mugny & Doise (1978)	**Collective performance**: NA
Muller & Perlmutter (1985)	**Problem-solving interaction**: NA
Tudge (1992)	**Peer collaboration**: NA

Figure 4. CPS definitions and other terminologies

I analyzed the selected articles to extract the following information (see figure 3): CPS and related terminologies (e.g., collaborative problem solving, peer collaboration, mutual coordination); types of play (child-led play and adult-directed play); settings for evaluating CPS (experimental and nonexperimental settings); and research methodology (quantitative, qualitative, and mixed methods).

Results

Definitions of CPS and Related Terminologies

The eighteen studies I reviewed used varying terminologies to describe CPS and related concepts (see figure 4). Specifically, two studies employed the term cooperative problem solving, six studies referred to collaborative problem solving, and ten studies adopted other terminologies. Notably, Ashley and Tomasello (1998) and Ramani (2012) conceptualized CPS similarly, highlighting the collaboration of two children to solve external problems. Additionally, studies employing the term collaborative problem solving emphasized the development of mutual goals and the utilization of behavioral and social-cognitive skills to coordinate actions (Cooper 1980; Domberg et al. 2021; Garton and Pratt 2001; Holmes-Lonergan 2003; Warneken et al. 2014). Although Azmitia (1988) focused on collaborative problem solving, she did not furnish a specific definition.

Furthermore, ten studies employed diverse terminologies such as cooperation, peer collaboration, team collaboration, joint action, and interactive contexts. However, only six of these studies supplied accompanying definitions (Arterberry et al. 2007; Cannella 1993; Duran and Gauvain 1993; Gauvain and Rogoff 1989; Hamann et al. 2012; Koymen and Tomasello 2018). Their definitions aimed to elucidate a process involving mutual assistance, elucidation of diverse perspectives, contribution of novel insights, cultivation of a shared problem understanding, and collaborative decision making for effective problem-solving strategies.

CPS in Experimental and Play Contexts

The majority of the eighteen studies were conducted in experimental settings where child participants engaged in specific tasks designed by researchers (see figure 5). Only two studies—Muller and Perlmuter (1985) and Ramani (2012)—used playful settings, although they maintained structured conditions. Muller and Perlmuter's experiments explored children's problem-solving interactions: one assessed interactions involving computer use in a preschool classroom,

and the other compared problem-solving interactions during puzzle play in the same environment. Although they provided general descriptions for the interactions during puzzle play, Muller and Perlmuter conducted no statistical comparison analysis.

In Ramani's study, children worked with a partner to construct a playhouse within a playful setting. The study differentiated this playful condition from a structured one by offering nondirective suggestions, though children still adhered to specific standards for playhouse construction. The study aimed to compare preschool children's task performance, cooperation, and motivation using a playful, child-directed dyadic activity and a more structured, adult-directed dyadic activity. Results revealed that dyads in the playful condition employed a higher proportion of suggestions, narration, and agreements compared to those in the structured condition. Additionally, children in the playful condition demonstrated increased levels of observation and imitation relative to their counterparts in the structured condition.

Regarding the types of play in which children engage, both studies used constructive play, enabling children to employ objects to organize or construct something in a goal-oriented manner (Smilansky 1986). However, the studies incorporated no other types of play.

In various experimental or playful settings, children were situated in diverse forms of interaction. Ten studies involved children working in pairs (Ashley and Tomasello 1998; Cooper 1980; Domberg et al. 2021; Duran and Gauvain 1993; Hamann et al. 2012; Holmes-Lonergan 2003; Koymen and Tomasello 2018; Mugny and Doise 1978; Ramani 2012; Warneken et al. 2014). Seven studies explored children working independently or in pairs (Arterberry et al. 2007; Azmitia 1988; Cannella 1993; Garton and Pratt 2001; Gauvain and Rogoff 1989; Muller and Perlmuter 1985; Tudge 1992). Only one study involved children grouped in four (Charlesworth and Dzur 1987). The eighteen studies paired or grouped children based on factors such as sex, age, individual ability, or classroom placement.

CPS Evaluation Across Age, Ability, and Sex

The studies divided CPS into verbal and nonverbal behaviors. Specifically, they categorized verbal behaviors into twenty main behaviors with twenty-eight subbehaviors, while they categorized nonverbal behaviors into fifteen main behaviors with seventeen subbehaviors. They developed specific coding systems and associated definitions for each code to evaluate the frequency, duration, or

Articles	Play/Task Names	Forms of Interaction	Forms of Pairs	Conditions/Contexts	CPS Skills	Additional Assessment
Arterberry, et al. (2007)	60-piece Ravensburger Paddington Bear jigsaw puzzles	Work alone vs. Work as pairs	Same-sex	Alone condition vs. paired condition; No evaluation condition vs. evaluation condition; Easy puzzle condition vs. hard puzzle condition	Amount of time for fighting, independent work, cooperating, competing, and off-task	The number of pieces placed correctly; the amount of time for task completion
Ashley & Tomasello (1998)	Testing Apparatuses	Work as pairs	mixed-sex & same-sex	Phase 1: Cooperation task; Phase 2: Reversal task; Phase 3: Teaching; Phase 4: Reversal for secondary subjects	Frequency of behaviors - coordination attempt, independent manipulation, investigation, experimenter focus, and not focusing on tasks	Frequency of task success
					Frequency of communication - demonstration, specific direction, generic directive explanation, attention directing, responsiveness, and direct language/gesture to experimenter	
Azmitia (1988)	Copying Complex Lego models	Work alone vs. work as pairs	same-sex	Alone condition vs. same-ability condition vs. mixed-ability condition	Frequency of verbal strategies - task-related statements, explanations, and demonstrations	Task engagement - percentages of time on task; frequency of looking at a model
				Individual pretest; Interactive sessions; Individual post-test	Frequency of facilitation - disagreements, observational learning, and guidance by expert	

Figure 5. Descriptive analysis of methods of each publication

Cannella (1993)	Adapted Three Mountains Tasks	Work alone & work in pairs	mixed-sex & same-sex	Individual pretest; Interactive sessions; Individual post-test	Levels of cognitive negotiation strategies (0-3)	Levels of developmental performance (1-3)
					Levels of shared cognitive experience (0-3)	The number of problems solved correctly
Charlesworth & Dzur (1987)	Movie Viewer Apparatus	A group of 4 children	same-sex	Group condition	Amount of time for cooperating	The amount of time viewing the film; the amount of time bystanding
					Frequency of verbal behaviors - request, command/positive or negative directives, appeals to rules for taking turns, expressing personal need, threats/ridicules, offering others position, and showing concern	Percentages of individual affect (positive, negative, neutral, mixed)
					Frequency of physical behaviors - approaches, touches/grasps, blocks, covers with hand, pushes/pulls/hits, attacks, and disrupts	

Figure 5. Descriptive analysis of methods of each publication (continued)

Cooper (1980)	Matching Weight game	Work as pairs	same-age; same-sex	Paired condition	Frequency of communication - attention-focusing statement, question/request for information, directive/request for action, comment relevant to the task, comment irrelevant to the task, ignoring of directive/question, verbal response to directive, nonverbal response to directive, evaluating feedback, description of blocks with accurate label, description with accurate attribute, description with inaccurate attribute, and comparative description	The number of successfully matched pairs of blocks; the total number of pairs placed on the scales; the ratio of matched pairs to total attempts; the amount of time spent on the task
Domberg et al. (2021)	Decorating Pictures games	Work as pairs	same-age; same-sex	Competitive condition vs. non-competitive condition	Frequency of reasons in children's talk - explanation Frequency of child commenting on their partner's proposals and reasons.	Manipulation check - children's awareness of group-competitive situation
Duran & Gauvain (1993)	Delivery Planning tasks	Work as pairs	same-age & mixed-age; mixed-ability (novice and expert planners)	Individual pretest; Interactive sessions; Individual post-test	Frequency of planning strategies - strategy statements Frequency of partner's task involvement Frequency of interactional process - observational learning, guidance by the expert, and conflicting statements/disagreements	Levels of plan effectiveness (novice and expert)

Figure 5. Descriptive analysis of methods of each publication (continued)

Garton & Pratt (2001)	Sorting tasks	Work alone vs. work as pairs	same-age; same-sex; same-ability & mixed ability	Individual pretest; Interactive sessions; Individual post-test	Frequency of utterance - procedural, command, plan, descriptive, self-talk, off-task statements, questions experimenter, inaudible/incomplete, checking, and turn-taking	Levels of sorting ability (high and low)
Gauvain & Rogoff (1989)	Grocery Shopping tasks (Experiment 1)	Work alone vs. work as pairs	same-age; same-sex	Alone condition vs. paired condition	Frequency of problem definition, efficiency concerns, and organizing task Plan effectiveness scores- route efficiency Frequency of division of labor and sharing responsibility	Levels of advanced scanning strategies (1-3) - store survey strategy and item-location scanning strategy
	Grocery Shopping tasks (Experiment 2)	Work alone vs. work as pairs vs. mother-child pairs	same-age; same-sex	Alone condition vs. paired condition vs. mother-child working condition Individual post-test	Frequency of problem definition, efficiency concerns, and organizing task Plan effectiveness scores- route efficiency Frequency of division of labor and sharing responsibility	Levels of advanced scanning strategies (1-3) - store survey strategy and item-location scanning strategy
Hamann et al. (2012)	Testing Apparatuses (Experiment 1)	Work as pairs	same-age	Collaborative condition vs. baseline condition	Frequency of collaborative help - immediate, delayed, and no support	-

Figure 5. Descriptive analysis of methods of each publication (continued)

					Frequency of communicative acts - ask for help, state descriptions, referential utterances, and signs of discontent	
	Testing Apparatuses (Experiment 2)	Work as pairs	same-age	Collaborative condition vs. baseline condition	-	Proportion of trials to retrieve two rewards
Holmes-Lonergan (2003)	Tinkertoy Structure Building tasks	Work as pairs	same-sex & mixed-sex	Structured condition vs. less-structured condition	Frequency of verbal interaction - controlling, mitigating, asking for/receiving information, miscellaneous, countering, agreement, offering reasons, and talking to experimenter	Percentage of task success - overall success, efficiency selection, and efficiency placement
					Frequency of nonverbal behaviors - controlling, mitigating, indecision, and gesturing toward a model	
Koymen & Tomasello (2018)	Placing correct items games (Experiment 1)	Work as pairs	same-age; same-sex	unequal reliability condition vs. equal reliability condition vs. same information condition	Frequency of no-disagreement, giving up, turn-taking, and justification	The number of "correct items" chosen by children
					Frequency of meta-talking - advanced meta-talk, questions, quotes, and no meta-talk	
				Strong evidence clip vs. weak evidence clip		
	Placing correct items games (Experiment 2.1)	Work with a puppet	-	Strong evidence condition vs. weak evidence condition	Frequency of meta-talk, quotes, and no/incomplete/irrelevant justifications	The rates of correct responses

Figure 5. Descriptive analysis of methods of each publication (continued)

						The number of "correct items" chosen by children
	Placing correct items games (Experiment 2.2)	Work with a puppet	-	Strong evidence condition vs. weak evidence condition	Frequency of meta-talk, quotes, and no/incomplete/irrelevant justifications	The rates of correct responses
						The number of "correct items" chosen by children
Mugny & Doise (1978)	Trois Montagnes (Three Mountains) Experiment	Work as pairs	same-ability & mixed-ability; same-sex	Individual pretest; Interactive sessions; Individual post-test	-	Collective performance - the number of correct performance
						Individual performance
Muller & Perlmutter (1985)	Computer Games (Experiment 1)	Work alone vs. work with peers vs. work with a teacher	-	Computer area in a classroom	Frequency of initiation of interaction - self-requested, peer-requested, and teacher-requested	Frequency of using a computer; time spent on a computer
					Frequency of forms of interaction - turn-taking, performing required actions for another child, demonstrating required actions, and explaining	Time spent on interaction - alone, peer interaction, and teacher-child interaction

Figure 5. Descriptive analysis of methods of each publication (continued)

	27-piece Wooden jigsaw puzzles (Experiment 2)	Work alone vs. work with peers vs. work with a teacher	-	Puzzle area in a classroom	Frequency of initiation of interaction - self-requested, peer-requested, and teacher-requested	Time spent on each puzzle
					Frequency of forms of interaction - turn-taking, performing required actions for another child, demonstrating required actions, and explaining	Time spent on interaction - alone, peer interaction, and teacher-child interaction
Ramani (2012)	Building Tasks	Work as pairs	same-age; same-sex	Playful condition vs. structured condition	Frequency of cooperative interaction - asking questions, explanations, directives, and demonstration	Building performance - building complexity, building completeness, and number of blocks in the building
				Baseline session vs. experimental session vs. post-test session	Frequency of joint communication - suggestions, narration, and agreements Frequency of shared task responsibility - coordinating action, negotiating, and dividing labor Frequency of observational learning - observation and imitation Frequency of unproductive behavior/communication - controlling peer, disagreements, and verbalization to experimenter	Motivation - percentage of task engagement, child rating of task enjoyment (1-5), and adult rating of task enjoyment (1-4)

Figure 5. Descriptive analysis of methods of each publication (continued)

Tudge (1992)	Mathematical Balance Beam	Work alone vs. work as pairs	same-sex; same-classroom; same-ability & mixed-ability	Individual pretest; Interactive sessions; Individual post-test	Frequency of justification - no/idiosyncratic justification, considering only the number of weights, irrespective of distance when the number of weights was equal, and considering distance from the fulcrum when the number of weights was unequal	Level of using rules (0-6)
				Control group vs. equal-rule group vs. un-equal rule group	Level of reasoning exposed and reasoning adopted (same, lower, and higher levels)	
					Frequency of reasoning accepted	
Warneken et al. (2014)	Problem-Solving Apparatus	Work as pairs	same-sex; same-age	Bidirectional condition vs. unidirectional condition	Frequency of communication - announcements/comments about own/partner's actions, and explanations/conditionals	Frequency of task success

Figure 5. Descriptive analysis of methods of each publication (continued)

intensity of these behaviors (see figure 6). Six out of the eighteen studies did not assess CPS (Arterberry et al. 2007; Mugny and Doise 1978), or they used CPS solely as an independent variable (Cannella 1993; Cooper 1980; Muller and Perlmuter 1985; Tudge 1992). In essence, twelve studies examined CPS behaviors, all of which were comparative studies aiming to gauge the impact of various conditions, age, personal ability, and sex on CPS.

Age Differences

Six studies found age-related differences in both verbal and nonverbal CPS behaviors, noting that older children displayed a greater tendency toward verbal engagement compared to younger children. Ashley and Tomasello (1998) explored CPS and teaching abilities among toddlers and young preschoolers by pairing them with same-age partners for a CPS apparatus task. Each dyad progressed through three phases (cooperation, reversal task, and teaching), with CPS behaviors observed and measured. Results revealed that 3.5-year-olds coordinated with their partners more frequently than 3.0- and 2.5-year-olds, and they also used more specific directives and demonstrations. Similarly, Warneken and his associates (Warneken et al. 2014) examined children's performance and tool selection in a collaborative task, finding that 5.0-year-olds produced more task-relevant utterances compared to 3.0-year-olds.

Two additional studies compared the CPS behaviors of seven-year-olds with those of five-year-olds (Domberg et al. 2021; Koymen and Tomasello 2018). Although the focus of the literature review was not on seven-year-olds specifically, since these studies also involved five-year-olds, their findings were included for analysis. Both studies demonstrated that seven-year-olds exhibited a greater inclination towards verbal behaviors compared to their five-year-old counterparts. For instance, Domberg and her associates (Domberg et al. 2021) examined children's CPS in competitive and noncompetitive conditions, pairing them with same-age and same-sex partners. Results indicated no significant differences between conditions but revealed age-related disparities; specifically, seven-year-olds engaged more frequently in reasoning and transactions (one child commenting on a partner's proposals and reasons) during discussions compared to five-year-olds. Similarly, Koymen and Tomasello (2018) investigated how children engaged in meta-talk (a reference to information reliability) and reached joint decisions while solving problems collaboratively. They discovered that seven-year-olds were more prone to justifying their disagreements and engaging in meta-talk than five-year-olds.

Articles	Sample Size	Mean Age	Age Range	Independent Variable	CPS Skills	F-score/T-score/χ^2 score (Sig.)
Arterberry, et al. (2007)	192	5.52	5 to 5.9	No evaluation condition vs. evaluation condition	Amount of time for cooperating	N/A
				Easy puzzle condition vs. hard puzzle condition"		
Ashley & Tomasello (1998)	8	2	1.91 to 2.08	Age	Frequency of behaviors - coordination attempt, independent manipulation, investigation, experimenter focus, and not focusing on tasks	Phase 1: F(10,34) = 6.63 (p < .01); Phase 2: F(2,21) = 3.19 (p = .06.); Phase 3: F(8.34) = 4.50 (p < .01)
	16	2.58	2.25 to 2.67		Frequency of communication - demonstration, specific direction, generic directive, explanation, attention directing, responsiveness, and direct language/gesture to experimenter	Phase 1: F(12.34) = 2.19 (p < .05); Phase 3: F(12,30) = 2.07 (p < .05)
	16	3	2.92 to 3.08	Phase 1 vs. Phase 3	Frequency of behaviors - coordination attempt	2.5 yrs: t(13) = 1.97 (p <.05); 3 yrs: t(14) = 12.93 (p < .01); 3.5 yrs: t(14) = 4.26 (p < .01)
					Frequency of behaviors - investigation	2.5 yrs: t(13) = 4.23 (p < .01); 3 yrs: t(14) = 5.97 (p < .01); 3.5 yrs: t(14) = 9.61 (p < .01)
					Frequency of behaviors - not focusing on tasks	2.5 yrs: t(13) = 3.57 (p < .01); 3 yrs: t(14) = 3.03 (p < .05); 3.5 yrs: t(14) = 3.41 (p < .01)
					Frequency of communication - specific direction	3 yrs: t(14) = 1.80 (p < .05)
					Frequency of communication - attention directing	3 yrs: t(14) = 2.33 (p < .05)
					Frequency of communication - responsiveness	3 yrs: t(14) = 2.37 (p < .05)
Azmitia (1988)	80	5.1	4.6 to 5.6	Condition (alone, same-ability, and mixed-ability)	Frequency of verbal strategies - task-related statements, explanations, and demonstrations	F(3,48) = 2.72 (p < .05)
				Ability (novice and expert)		F(2, 48) = 3.09 (p < .05)
				Session (pretest, interactive, and posttest)		F (3, 48) = 3.48 (p < .05)

Figure 6. Information on CPS skills assessment

				Condition (alone, same-ability, and mixed-ability)	Frequency of facilitation - disagreements, observational learning, and guidance by expert	N/A
				Ability (novice and expert)		
				Session (pretest, interactive, and posttest)		
Cannella (1993)	66 a	5.5	5.17 to 6.67	*CPS skills (levels of cognitive negotiation strategies and shared cognitive experience) were used as independent variables*		
		6.75	6.17 to 7.5			
Charlesworth & Dzur (1987)	80	N/A	4 to 5.17	Sex	Amount of time for cooperating	F(39,39) = 2.16 (p < .05)
					Frequency of verbal behaviors - request, command/positive or negative directives, appeals to rules for taking turns, expressing personal need, threats/ridicules, offering others position, and showing concern	t(78) = 1.94 (p < .1)
					Frequency of physical behaviors - approaches, touches/grasps, blocks, covers with hand, pushes/pulls/hits, attacks, and disrupts	t(78) = 2.30 (p < .05)
				High resource utilization vs. low resource utilization	Amount of time for cooperating	Girl: t(18) = N.S; Boy: t(18) = 2.24 (p < .05)
					Frequency of verbal behaviors - request, command/positive or negative directives, appeals to rules for taking turns, expressing personal need, threats/ridicules, offering others position, and showing concern	Girl: t(18) = 2.88 (p < .01); Boy: N/A
					Frequency of physical behaviors - approaches, touches/grasps, blocks, covers with hand, pushes/pulls/hits, attacks, and disrupts	Girl: t(18) = 2.22 (p < .05); Boy: N/A
Cooper (1980)	32	3.42	3.08 to 3.75	*Communication behaviors were used to assess their relationship with task success*		
	32	4.33	4 to 4.75			
Domberg et al. (2021)	64	5.75	N/A	Age	Frequency of reasons in children's talk - explanation	$\chi 2 = 10.47$ (p = .001)
	64	7.5	N/A		Frequency of child commenting on their partner's proposals and reasons.	$\chi 2 = 10.89$ (p < .001)
				Condition (competitive vs. non-competitive)	Frequency of reasons in children's talk - explanation	$\chi 2 = 1.92$ (p = .17)

Figure 6. Information on CPS skills assessment (continued)

				Game (zoo vs. dollhouse) x Condition	Frequency of reasons in children's talk - explanation	Dollhouse: $\chi2 = 8.81$ ($p = .003$); Zoo: $\chi2 = 19.83$ ($p < .001$)
					Frequency of child commenting on their partner's proposals and reasons.	Dollhouse: $\chi2 = 5.67$ ($p = .017$); Zoo: $\chi2 = 19.83$ ($p < .001$)
Duran & Gauvain (1993)	24	5.5	5.2 to 5.9	Age group (same-age vs. mixed-age)	Frequency of planning strategies - strategy statements	Novice: F(l, 16) = 4.01 (p = .06)
	8	7.5	7.2 to 7.9		Frequency of partner's task involvement	Novice: F(l, 16) = 5.43 ($p < .05$)
					Frequency of interactional process - conflicting statements/disagreements	F(l, 16) = 3.23 (p = .09)
				Age	Frequency of interactional process - guidance by the expert	F(l, 16) = 5.37 (p = .05)
Garton & Pratt (2001)	119	4.75	4.33 to 5.5	Age	Frequency of utterance - procedural, command, plan, descriptive, self-talk, off-task statements, questions experimenter, inaudible/incomplete, checking, and turn-taking	F(1,59) = 3.94 ($p < .05$)
	103	7.25	6.92 to 8.17			
				Ability		F(1,58) = 5.34 ($p < .05$).
Gauvain & Rogoff (1989)	48 a (Experiment 1)	5.8	4.5 to 6.9	Age	Frequency of problem definition, efficiency concerns, and organizing task	F(l, 28) =18.16 ($p < .01$)
		9.1	8.7 to 10.3		Frequency of sharing responsibility	$\chi2 = 6.76$ ($p < .01$)
	36 a (Experiment 2)	5.7	4.5 to 6.1	Forms of Interaction (work alone vs. work as pairs vs. work with mother)	Frequency of problem definition	F {2, 24) = 4.00 (p = .03)
					Frequency of efficiency concerns	F(2, 24) = 10.00 ($p < .01$)
					Frequency of division of labor	F(1, 16) = 18.12 ($p < .01$)
					Frequency of sharing responsibility	$\chi2 = .28$ ($p > .05$)
Hamann et al. (2012)	12 (Experiment 1)	2.67	2.58 to 2.83	Age	Frequency of collaborative help - immediate, delayed, and no support	F(1, 22) = 140.82 ($p < .001$)
	12 (Experiment 1)	3.67	3.5 to 3.83			
	12 (Experiment 2)	2.75	2.58 to 2.83	*CPS skills were not assessed*		

Figure 6. Information on CPS skills assessment (continued)

Holmes-Lonergan (2003)	60	4.67	3.92 to 5.42	Sex Group (same-sex vs mixed-sex)	Frequency of nonverbal behaviors - controlling	F(2, 56) = 4.89 (p = .01)
				Sex	Frequency of verbal interaction - mitigating	F(2, 36) = 7.09 (p = .01)
					Frequency of verbal interaction - agreement	F(1, 35) = 7.65 (p = .009)
Koymen & Tomasello (2018)	98	5.75	5.5 to 6	Condition (unequal reliability condition vs. equal reliability condition vs. same information condition)	Frequency of justification	$\chi2 = 48.53$ ($p < .001$)
	98 (Experiment 1)	7.5	7.08 to 8		Frequency of meta-talking - advanced meta-talk, questions, quotes, and no meta-talk	$\chi2 = 28.71$ ($p < .001$)
				Age	Frequency of justification	$\chi2 = 13.23$ ($p < .001$)
					Frequency of meta-talking - advanced meta-talk, questions, quotes, and no meta-talk	$\chi2 = 14.01$ ($p < .001$)
				Evidence clip (strong vs. weak)	Frequency of justification	$\chi2 = 7.61$ ($p = .006$)
	40	3.75	3.5 to 4	*Experiment 2.1 did not include child-child collaboration*		
	40 (Experiment 2.1)	5.75	5.42 to 6.08			
	21	3.83	3.58 to 4	*Experiment 2.2 did not include child-child collaboration*		
	19 (Experiment 2	5.75	5.5 to 6			
Mugny & Doise (1978)	74	N/A	5 to 7	*CPS skills were not assessed*		
Muller & Perlmutter (1985)	27 (Experiment 1)	4.33	3.67 to 5.58	*Experiment 1 was conducted in a technology-mediated environment.*		
	18 (Experiment 2)	4.33	3.42 to 5.08	*Patterns of behaviors were analyzed descriptively and compared with the behaviors in a technology-mediated environment.*		
Ramani (2012)	40	4.42	N/A	Condition (playful vs. structured)	Frequency of joint communication - suggestions, narration, and agreements	F(1, 30) = 12.29 (p < .01)
	36	5.33	N/A		Frequency of observational learning - observation and imitation	F(1, 32) = 4.14 (p = .05)
Tudge (1992)	51	5.55	5 to 6	*CPS skills were used to assess their impact on rule use.*		
	55	6.83	6 to 8.33			

Figure 6. Information on CPS skills assessment (continued)

	47	9.33	8.25 to 11.17			
Warneken et al. (2014)	24	3.25	3 to 3.42	Age	Frequency of communication - announcements/comments about own/partner's actions, and explanations/conditionals	F(1, 21) = 3.45 (p = .077)
	24	5.33	5 to 5.42			

Note: "a" did not provide the number of children in each age group.

Figure 6. Information on CPS skills assessment (continued)

Regarding nonverbal behaviors, the research yielded mixed results concerning age differences. Duran and Gauvain (1993) explored the impact of age and expertise on collaboration during joint planning. They observed that 5.0-year-old experts offered more positive support for novices compared to 7.0-year-old experts. Conversely, Hamann and her associates (Hamann et al. 2012) conducted two experiments, in which the first one focused on investigating young children's commitment to a joint goal in a collaborative activity. Their findings revealed that 3.5-year-olds provided significantly more support than the 2.5-year-olds.

Ability Differences

Only one study delved into differences in verbal and nonverbal CPS behaviors based on ability. Azmitia (1988) examined the performances of preschoolers on construction tasks both individually and collaboratively. The children were categorized as novices or experts and randomly assigned to either solitary, same-ability, or mixed-ability conditions. The findings revealed that same-ability dyads engaged in more task-related conversation compared to mixed-ability pairs. Specifically, experts provided more correct explanations and demonstrations than novices. In same-ability dyads, experts allocated more time observing their partners, whereas novices spent more time observing their partners in mixed-ability pairs.

Sex Differences

Two studies examined sex differences in verbal and nonverbal CPS behaviors. Charlesworth and Dzur (1987) explored gender disparities in a same-sex group problem-solving scenario. Their findings revealed that while girls issued more negative commands than boys, they also provided each other access to different positions to access materials. Moreover, girls were more prone than boys to approach

each other without physical contact, whereas boys exhibited a higher frequency of negative behaviors such as grasping, pushing, pulling, and hitting compared to girls.

Holmes-Lonergan (2003) examined sex differences in problem-solving and conflict-resolution skills among preschool children. The study revealed that children in mixed-sex dyads were more inclined to employ controlling behavior compared to those in same-sex dyads. Specifically, girls in same-sex dyads used agreements more frequently than boys in same-sex dyads, whereas, in mixed-sex dyads, boys employed agreements more than girls. Furthermore, when not provided with specific task instructions, boys tended to focus more on individual goals rather than joint goals, whereas girls were more likely to engage in mitigating behaviors such as offering suggestions and proposing joint plans or compromises, compared to boys.

Age and Ability Variance

Garton and Pratt (2001) explored communication patterns in collaborative problem-solving contexts. They observed that seven-year-olds employed more procedural and descriptive language compared to four-year-olds. Additionally, regardless of age, children in both lower-ability groups used language to check with their partners more frequently.

Age and Sex Variance

Gauvain and Rogoff (1989) conducted two experiments to investigate the impact of planning with a partner and the connection between collaborative planning and subsequent solo planning. Their findings indicated that older children exhibited greater responsibility for searching for items compared to younger children. Additionally, girls planning with peers expressed more concern about task management than boys did, regardless of age.

In addition to assessing CPS, the studies encompassed various additional variables such as task completion, affection percentages, levels of sorting abilities, and scanning strategies. However, because these variables were not the primary focus of this literature review, I omitted them from the analysis of findings.

Discussion

This systematic review examined eighteen empirical studies to identify key patterns, highlight methodological and conceptual gaps, and propose directions

for future research that can inform both theory and practice. Initially, the study delved into the various terminologies and definitions of CPS. Subsequently, it explored how CPS manifests in play contexts by analyzing children's CPS behaviors in different settings. Lastly, the review investigated the impact of factors like age, gender, and cognitive abilities on CPS to better understand its multifaceted nature.

Definitions of CPS

The common themes among the definitions of CPS center on members, problems, and procedures. In the context of CPS, the involvement of two or more children is essential, necessitating the cultivation of a shared comprehension regarding the problem they aim to tackle collectively. For example, two studies defined CPS as "two children must cooperate in order to solve an external problem" (Ashley and Tomasello 1998; Ramani 2012). Other scholars who have explored collaborative problem solving have also underscored the importance of establishing a shared problem or objective to enable group members to collaborate effectively toward its resolution (Arterberry et al. 2007; Cannella 1993; Duran and Gauvain 1993; Gauvain and Rogoff 1989; Hamann et al. 2012; Koymen and Tomasello 2018). The process of setting shared goals is crucial for directing participants' actions towards specific objectives, which in turn promotes collaborative decision making for more effective solutions (Cooper 1980; Domberg et al. 2021; Garton and Pratt 2001; Holmes-Lonergan 2003; Warneken et al. 2014).

The review findings indicated that children did not autonomously establish a shared goal. Rather, they were often placed in situations to complete tasks as requested by experimenters or to earn rewards. Additionally, the experimenters frequently made the decision with whom to collaborate for play and problem solving. In real-life settings, it remains unclear how children choose friends with whom to play, establish a mutual understanding of a problem, and develop shared goals for solving it. Do children need to establish a mutual goal first to solve a problem effectively? Or are they more likely to go with the flow, trying immediate solutions to see if they work? Alternatively, might they not recognize a situation as a problem but still want to help their friends address it? To generalize this definition to real-life situations for young children—such as during play in classrooms and on playgrounds—further studies are necessary to situate children in these environments.

The Measure of CPS

From an operational standpoint, CPS can be categorized into verbal actions (such as suggestions, explanations, and planning) and nonverbal behaviors (including cooperation, demonstration, and observation). Both categories are observable and measurable. Observation is typically the primary research method, in which relevant behaviors coded using evolving CPS coding systems. The frequencies of these behaviors, along with their duration, are often analyzed statistically to identify differences among children based on various factors, such as conditions, age, ability, and sex (Arterberry et al., 2007; Ashley and Tomasello 1998; Azmitia 1988; Charlesworth and Dzur 1987; Domberg et al. 2021; Duran and Gauvain 1993; Garton and Pratt 2001; Gauvain and Rogoff 1989; Hamann et al. 2012; Holmes-Lonergan 2003; Koymen and Tomasello 2018; Ramani 2012; Warneken et al. 2014).

CPS is a complex skill that includes various verbal actions and nonverbal behaviors, requiring careful consideration of how each action or behavior—and its categorization—represents CPS. For instance, should children be regarded as exhibiting stronger CPS skills if they show greater agreement with their partners, even if they are primarily followers who tend to concur with others' suggestions? Additionally, when relevant actions are grouped into categories, as Ramani did with observational learning (observation and imitation), does a higher proportion of observational learning indicate greater engagement in CPS? The key point is that CPS has not been fully evaluated as a cohesive behavior or skill. Current research tends to analyze its components, highlighting specific actions, behaviors, or categories that some children exhibit more frequently than their peers. None of the existing studies provides concrete conclusions about children's CPS as a whole, indicating a need for measurement tools specifically designed to assess children's CPS skills comprehensively.

Toward Classroom-Based CPS Research

Only one study, conducted by Ramani (2012), explored the relationship between children's CPS and play and developed significant findings. Ramani found that children in a playful setting exhibited a higher proportion of suggestions, narration, and agreements compared to those in an adult-structured environment. Although the positive relationship between play and CPS associated behaviors

has been well documented theoretically and practically, it still lacks systematic research conducted in a daily context to unfold their in-depth relationship. To understand the complex nature of this relationship better, we need further research.

The eighteen studies provided a comprehensive understanding of the components of CPS. However, we need further research to explore children's CPS in everyday classroom contexts. These contexts are complex, and they are influenced by children's immediate experiences and cultural differences and by the pedagogical decisions of their teachers. While it is valuable to reference existing research on children's CPS during play, we must continue to investigate this topic with new approaches in everyday play episodes. For instance, although the CPS behaviors outlined in this article may manifest in classroom settings, new or different components of CPS could emerge when we study children in situ.

Preschool children engage in various types of play and a range of play episodes during their daily classroom activities, where teachers select a variety of materials and create related learning centers. While researchers can choose specific play materials, games, and settings for their research purpose, teachers also have their own preferences for these selections in their classrooms based on their pedagogical perceptions. Children typically do not play in sanitized environments with materials chosen by those unfamiliar with them, nor do they operate under imposed time constraints set by outsiders. As Rogoff and Morelli (1997) argued, experimental approaches inherently limit our understanding of the nuanced aspects of children's diverse developmental characteristics of CPS in relation to their cultural contexts. Rather than narrowing the research scope to contrived play episodes in experimental settings, we need to shift our focus to the natural, everyday occurrences in children's classrooms.

Primary Contributions

The significance of this systematic review lies in two primary contributions. First, although CPS has been widely acknowledged as a critical competency for twenty-first-century learning, research on CPS during the preschool years remains limited in scope compared to studies involving older children and adults. Second, the methodological emphasis on experimental designs constrains our understanding of how CPS naturally emerges within the everyday context of classroom play, a core setting for early childhood learning and development.

By synthesizing current empirical findings and identifying key methodological limitations, this review establishes a foundation for future research that is ecologically valid and situated within the lived experiences of young children in early educational settings.

Limitations

While this systematic review offers valuable insights into children's cooperative problem solving and its relationship with play, several limitations should be acknowledged. First, the review is based on a relatively small body of literature (n = 18), which is likely attributable to the specific inclusion criteria employed. The review focused primarily on the cognitive dimensions of CPS and excluded studies addressing related constructs such as conflict resolution, which often involve socio-emotional processes closely tied to CPS. Furthermore, the mental health of care givers—such as teachers' stress or emotional well-being—lay outside the scope of this review, despite evidence suggesting that such factors may shape the quality of children's CPS experiences.

Additionally, this review was limited to peer-reviewed journal articles and excluded gray literature, including dissertations and research reports. Such an exclusion may have introduced publication bias and suggests a need for future reviews to include a broader range of sources to capture a more comprehensive view of the field. Another limitation involves technical challenges related to database indexing. For example, a relevant article by Jin and Moran, which examines children's CPS in play contexts, was indexed with a publication year of 2023 in databases such as ERIC, PsycInfo, and Web of Science, but may appear as 2022 in other search engines. As the systematic search concluded in September 2022, this discrepancy resulted in the article's omission. Future systematic reviews may consider including such studies to further enrich an understanding of CPS within naturalistic early childhood settings.

Conclusions

This systematic review examined the nature of peer cooperative problem solving and its relationship with play in early childhood settings. The findings underscore the complexity of CPS, which encompasses both verbal exchanges

and nonverbal behaviors. Children's engagement in CPS varies depending on contextual conditions, as well as individual factors such as age, sex, and ability. Moreover, the review identified a significant positive relationship between CPS-related behaviors and play. Despite growing recognition of CPS as a foundational skill for lifelong learning, research during the preschool years remains relatively limited, especially in comparison to studies focused on older children and adults. Furthermore, the predominant reliance on experimental designs constrains our understanding of how CPS naturally emerges within authentic, play-based classroom environments—the primary context for young children's development. By synthesizing the current body of literature and highlighting key methodological limitations, this review lays the groundwork for future research that is ecologically valid and grounded in the lived experiences of children in early educational settings.

References

Arterberry, Martha E., Kathleen M. Cain, and Stephanie A. Chopko. 2007. "Collaborative Problem Solving in Five-Year-Old Children: Evidence of Social Facilitation and Social Loafing." *Educational Psychology* 27:577–96. https://doi.org/10.1080/01443410701308755.

Ashley, Jennifer, and Michael Tomasello. 1998. "Cooperative Problem-Solving and Teaching in Preschoolers." *Social Development* 7:143–63. https://doi.org/10.1111/1467-9507.00059.

Azmitia, Margarita. 1988. "Peer Interaction and Problem Solving: When Are Two Heads Better Than One?" *Child Development* 59:87–96. https://doi.org/10.2307/1130391.

Bodrova, Elena, and Deborah J. Leong. 2007. *Tools of the Mind: The Vygotskian Approach to Early Childhood Education*. 2nd ed.

Cannella, Gaile S. 1993. "Learning Through Social Interaction: Shared Cognitive Experience, Negotiation Strategies, and Joint Concept Construction for Young Children." *Early Childhood Research Quarterly* 8:427–44. https://doi.org/10.1016/S0885-2006(05)80078-X.

Charlesworth, William R., and Claire Dzur. 1987. "Gender Comparisons of Preschoolers' Behavior and Resource Utilization in Group Problem Solving." *Child Development* 58:191–200. https://doi.org/10.2307/1130301.

Cooper, Catherine R. 1980. "Development of Collaborative Problem Solving Among Preschool Children." *Developmental Psychology* 16:433–40. https://doi.org/10.1037/0012-1649.16.5.433.

Cuffaro, Harriet K. 1995. *Experimenting with the World: John Dewey and the Early Childhood Classroom*.

Dewey, John. 1902. *The Child and the Curriculum*.
———. (1938) 1997. *Experience and Education*.
Domberg, Andreas, Michael Tomasello, and Bahar Köymen. 2021. "Collaborative Reasoning in the Context of Group Competition." *PLOS ONE* 16:e0246589. https://doi.org/10.1371/journal.pone.0246589.
Duran, Ruth T., and Mary Gauvain. 1993. "The Role of Age Versus Expertise in Peer Collaboration During Joint Planning." *Journal of Experimental Child Psychology* 55:227–42. https://doi.org/10.1006/jecp.1993.1013.
Garton, Alison F., and Chris Pratt. 2001. "Peer Assistance in Children's Problem Solving." *British Journal of Developmental Psychology* 19:307–18. https://doi.org/10.1348/026151001166092.
Gauvain, Mary, and Barbara Rogoff. 1989. "Collaborative Problem Solving and Children's Planning Skills." *Developmental Psychology* 25:139–51. https://doi.org/10.1037/0012-1649.25.1.139.
Hamann, Katharina, Felix Warneken, and Michael Tomasello. 2012. "Children's Developing Commitments to Joint Goals." *Child Development* 83:137–45. https://doi.org/10.1111/j.1467-8624.2011.01695.x.
Holmes-Lonergan, Heather A. 2003. "Preschool Children's Collaborative Problem-Solving Interactions: The Role of Gender, Pair Type, and Task." *Sex Roles* 48:505–17. https://doi.org/10.1023/A:1023523228455.
Köymen, Bahar, and Michael Tomasello. 2018. "Children's Meta-Talk in Their Collaborative Decision Making with Peers." *Journal of Experimental Child Psychology* 166:549–66. https://doi.org/10.1016/j.jecp.2017.09.018.
Mugny, Gabriel, and Willem Doise. 1978. "Socio-Cognitive Conflict and Structure of Individual and Collective Performances." *European Journal of Social Psychology* 8:181–92. https://doi.org/10.1002/ejsp.2420080204.
Muller, Alexandra A., and Marion Perlmutter. 1985. "Preschool Children's Problem-Solving Interactions at Computers and Jigsaw Puzzles." *Journal of Applied Developmental Psychology* 6:173–86. https://doi.org/10.1016/0193-3973(85)90058-9.
Piaget, Jean. 1951. *Play, Dreams, and Imitation in Childhood*. Translated by Caleb Gattegno and F. M. Hodgson.
———. 1983. "Piaget's Theory." In *Handbook of Child Psychology: History, Theory, and Methods*, vol. 1, 4th ed., edited by William Kessen, 103–28.
Ramani, Geetha B. 2012. "Influence of a Playful, Child-Directed Context on Preschool Children's Peer Cooperation." *Merrill-Palmer Quarterly* 58:159–90. https://doi.org/10.1353/mpq.2012.0011.
Rogoff, Barbara, and Gilda Morelli. 1997. "Perspectives on Children's Development from Cultural Psychology." In *Readings on the Development of Children*, 2nd ed., edited by Mary Gauvain and Michael Cole, 10–18.
Rubin, Kenneth H., William M. Bukowski, and Jeffrey G. Parker. 2006. "Peer Interactions, Relationships, and Groups." In *Handbook of Child Psychology: Social, Emotional, and Personality Development*, vol. 3, 6th ed., by Nancy Eisenberg, William Damon, and Richard M. Lerner, 571–645.

Smilansky, Sara. 1968. *The Effects of Sociodramatic Play on Disadvantaged Preschool Children*.

Tudge, Jonathan R. H. 1992. "Processes and Consequences of Peer Collaboration: A Vygotskian Analysis." *Child Development* 63:1364–79. https://doi.org/10.2307/1131562.

Van Hoorn, Judith, Patricia Monighan Nourot, Barbara Scales, and Keith Rodriguez Alward. 2011. *Play at the Center of the Curriculum*, 5th ed.

Vygotsky, Lev S. 1978. *Mind in Society: The Development of Higher Psychological Processes*.

Warneken, Felix, Jasmin Steinwender, Katharina Hamann, and Michael Tomasello. 2014. "Young Children's Planning in a Collaborative Problem-Solving Task." *Cognitive Development* 31:48–58. http://dx.doi.org/10.1016/j.cogdev.2014.02.003.