The Effects of Reinforcement for Collaboration in Preschoolers with Disabilities

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Submitted in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy
under the Executive Committee
of the Graduate School of Arts and Sciences

COLUMBIA UNIVERSITY

2025

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Abstract

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Collaboration is a required skill for individuals to engage in, from childhood and throughout adulthood. Collaboration is necessary for children to successfully play team sports, for students to work on group projects in college, and for adults to work productively on team projects in their professional careers. In education, collaboration occurs when two or more children work together to achieve a shared goal. Collaborative behaviors include communication, social interactions, and joint decision making. Research has demonstrated positive effects on collaboration in education (Barfield, 2016). However, there is a need to investigate the developmental trajectory of which reinforcement for collaboration can be established and any positive impacts of the cusp on socialization. Further, more research needs to be conducted on the effects of reinforcement for collaboration for children with disabilities. In Experiment 1, the researcher established reinforcement for collaboration in preschoolers with disabilities and evaluated the effects on learning, collaborative behaviors during a shared task, vocal verbal operants during a shared task, and joint attention with peers. Using multiple collaborative activities through a Social Listener Reinforcement (SLR) protocol, the participants demonstrated reinforcement for collaboration, as evident by increases in collaborative behaviors and vocal verbal operants to peers during a collaborative activity. The participants also demonstrated some increases in joint attention to peers and learned faster under collaborative contingencies. In Experiment 2, the researcher extended Experiment 1 by shortening the intervention, changing the learning measure, and adding more social validity measures. Experiment 2 evaluated the effects of establishing conditioned reinforcement for collaboration on collaborative behaviors during a

shared task, vocal verbal operants during a shared task, learning tacts in small group instruction, social skills, and preference for completing activities alone or with a peer. The results demonstrated a shortened intervention moderately increased collaborative and joint engagement behaviors during a floor puzzle and moderately increase the amount of vocal verbal operants emitted to a peer. The results also demonstrated that following intervention, the participants selected to complete activities with peers, versus alone, and learned faster in small group instruction. Findings from these experiments are discussed regarding educational significance for children with disabilities.

Keywords: collaboration, learning, social skills, verbal behavior

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Acknowledgments

While writing my acknowledgements, I have found myself writing “support” repeatedly. However, I think that speaks volumes to how truly supported I’ve felt throughout these five years. All to say, I could not have accomplished what I have without all of you. Thank you to my dissertation committee, Dr. Fienup, Dr. Sivaraman, Dr. Jahromi, Dr. Dudek, and Dr. Gautreaux for your guidance and feedback during this whole process. I am so grateful for the opportunity to have worked alongside you all and appreciate all you have done to help me grow.

Dr. Fienup, your mentorship has meant so much to me throughout the years. You have always had my best interest at heart, supported my research ideas, encouraged me as a teacher, and provided me with the positive reinforcement I often needed. Dr. Sivaraman, I appreciate all your guidance through this process, and I look up to you so much. You’re truly so inspiring! Dr. Jahromi, I have learned so much from you as you have challenged me to think outside the box and break out of my bubble, for that, I will always be grateful. Dr. Dudek, thank you for always stopping by my classroom to check in and problem-solve with me. I appreciate your realness and love for the science.

Thank you to all my mentors, Aparna, Jen, Gaby, and Kate, I am truly so lucky to have learned from you all. Aparna, you were the best first mentor I could’ve asked for. You instilled my love for teaching early on and inspired me to want to learn more. Kate, thank you for your guidance, always listening to my thoughts that often didn’t make much sense and answering a million questions. Thank you for always believing in me, motivating me, and pushing me to accomplish more.

Gaby, there are not enough ways to say thank you. Thank you for teaching me the ins and outs of Kindergarten, how to conduct research, write papers, and most importantly, be a good

teacher. I look up to you and am grateful to have had you, your support, and your friendship along the way! You continue to amaze me.

My girl, Tanya, although never officially a mentor, you have always felt like a mentor and been a shoulder to lean on for literally anything and everything. You have always been rooting for me, even when I wasn't rooting for myself. You once told me to never forget my worth and I've taken that to heart and would like to remind you to do the same. You're so special. I appreciate all you have done for me as a colleague and as a friend.

Katherine and Yoojin, my CABAS Survival Buddies, thank you for your constant support, friendship, and love. You guys singlehandedly kept me sane this year. I am so happy I have gone through this with you both, and don't know how I could've gotten here without our long phone calls, monthly dinners, or rants over boba. I admire you both and know you have such incredible futures ahead of you where you will continue to change children's lives!

To my mentees and teacher assistants that I've had the pleasure of working with over the years, thank you for putting our kids first and holding up the classroom at times! Jessica, I truly would not have been able to get my studies done without you and your sincere words of encouragement. I am so blessed to have had you as a teaching assistant the past two years, but I also feel blessed to have you as my friend. Thank you for always being there for me and our students, I appreciate you beyond words! To my students, you have taught me more than I could ever teach you.

I am so grateful to have such amazing friends that have kept me sane throughout these years. Sophia, I am so thankful we met in our master's program and can't imagine not having you in my life. You're the person I go to for everything and I know I can always count on you. Thank you to my sweet Caroline for your constant encouragement. Whether it was your words of

wisdom, celebratory sweet treats or just listening to me ramble on and on and on, I appreciate every moment of it. Briya, even though our texts were always brief and usually just consisting of "love you, have a good day," I am so grateful for your friendship. There's no one else like you.

Dan, when I think of support, I think of you. Thank you for your constant reminders that you're proud of me and that I am one smart cookie. Having you in my corner means the world to me, I appreciate you, and I love you.

To my grandma and mommom, I appreciate your weekly text check-ins and emails reminding me to enjoy life and not work too hard. Although I may have worked too hard, I'm so thankful I had you both reminding me to enjoy the ride! To my sister, Lauren, thank you for just being you and always supporting me in my endeavors. Maybe now I will take your advice and relax! Poppop and grandpa, although I wish you both were here to see my finished work, I felt your love and support along every step of the way. I am forever grateful to have had such cherishable years learning from you two. I love you and miss you every day. To my aunt Sue, you were always my biggest fan, and I hope I have made you proud, I miss you. To my cousin Jay, you were my first role-model in this field. I remember watching all your students in awe of you and it inspired me to find the same awe, so thank you.

To my mom and dad, my best friends, role-models, and biggest supporters, I truly could not have done this without you and your confidence in me. You were the first people I called when I had something to cry about, laugh about, scream about, complain about, or celebrate about. People always say that I look half like my mom and half like my dad. However, that is true to say beyond just our looks. Mom, your big heart of gold is what I admire most about you and is what inspires me daily with my students. You're truly my biggest cheerleader and knowing that I can always count on you is the best feeling in the world. Dad, your hard work-

ethic is so motivating and encouraging. If only I was as mathematically skilled as you, that would've come in handy when completing my statistics coursework. I am so lucky to have a dad that I look up to and find comfort in. Mom and dad, I have always felt your unwavering support and immense belief in me. You both have showed me what true *collaboration* looks like in our family; thank you for everything you have done for me. I love you.

Dedication

To my parents who never stopped believing in me.

Chapter 1: Introduction and Literature Review

1.1 Significance of Collaboration

There is growing evidence within the United States and internationally that suggests educational systems are not preparing students adequately to enter the workforce. It has been identified that collaboration, problem solving, communication, and creativity are critical skills for future workforce success (Fiore et al., 2017). According to The Assessment and Teaching of the 21st Century Skills (ATC21S), collaboration is among the most important skills necessary for a successful career (Fiore et al., 2017). There is an increasing need for individuals to work well with others (O'Neil et al., 2004, as cited in Scoular et al., 2020). When people can collaborate with others, they can effectively work well in groups, which is important to both school and work environments. Collaboration is the direct interaction between two parties who engage in shared decision making while working towards a shared goal (Cook & Friend, 1991). Specific behaviors may include: problem solving on a specific task through emitting intraverbals with another individual or placing Legos together to build a castle. Research suggests that collaboration includes shared responsibility for decision making, a shared common goal, and implies that activities are done so jointly (Cook & Friend, 1991). The literature on collaboration often uses the term *cooperation* interchangeably with collaboration. This distinction is important as literature uses the terms to mean different things in different contexts. Humans collaborate in various ways and across the lifespan. Daily endeavors involve collaboration, such as, playing a team sport, working on a science fair project with a group of classmates, searching for different items on a shopping list when at the grocery store with one's family, and when working for a company with multiple team members.

Collaboration is prevalent throughout one's entire lifetime. Collaboration is required within schooling, such as through group projects in high school and study groups in college. Collaboration continues to be essential in adulthood as individuals enter the workforce. Adults are often expected to collaborate with other employees across a variety of jobs. Although research has demonstrated the social significance to collaboration throughout life (Child & Shaw, 2016), it is important to understand at what age reinforcement for collaboration can be established and the effects it has on educational success.

1.2 Collaboration in Education

Children can learn to collaborate with one another as early as 3-5 yrs old (Tomasello & Hamann, 2012). Educators can teach children to emit collaborative behaviors by establishing reinforcement for collaboration. That is, by teaching children the positive outcomes of collaboration – such as reinforcement from peers, completion of an activity, etc. – this new reinforcer can select out specific collaborative behaviors (Greer, 2020). Collaborative behaviors are a key component to education and can be practically applied to any activity or service that a school professional engages in. Through peer teaching, collaborative learning, collaborative research, and collaborative curriculum development, educators promote students working together to achieve a shared goal (Barfield, 2016). Collaborative behaviors can be seen through dialogue, social interaction, and joint decision making with others (Barfield, 2016). Children who can collaborate with one another can share and play together, talk appropriately with another, and problem-solve situations together. For example, when children are working together to build a tower, they may engage in a conversation and jointly plan how to stack blocks to successfully build the tower together. Collaborative learning is an educational approach to teaching and learning that involves groups of learners working together to complete a task (Laal

& Laal, 2012). Collaborative learning shifts the emphasis from individual effort to multiple individuals working equally together to accomplish a goal (Laal & Laal, 2012).

When teachers arrange collaborative tasks, students have the opportunity to work together in groups to promote joint intellectual effort. However, that is not always the apparent case in many classrooms. Collaborative learning is based on the premise that learning is a "naturally social act" (Laal & Laal, 2012). Yet, individuals with autism spectrum disorder present often with deficits in social skills and may require supports and interventions to support social skills (Ozerk, et al., 2021). Collaborative learning tasks are intended to promote the most effective teaching possible for the greatest number of students (Laal & Laal, 2012). In general education classrooms, instruction is provided to either small groups or the whole class, in which students are expected to respond appropriately with peers, demonstrate self-management skills in a group of multiple students, and simultaneously learn the academic material. Along with academic expectations, it is equally as important to consider the expectations for young children's social skills, cooperation with others, and overall classroom behavior. For example, general education teachers expect students to be successful in tasks, such as playing with and sharing toys, playing in groups of multiple students, and using age-appropriate behavior and communication to problem-solve. Appropriate play with toys includes behaviors, such as, following rules and utilizing the toy in its' intended way. Using age-appropriate behavior and communication to problem-solve may look like a student vocally stating, "I was playing with that, can I have it back?" instead of screaming or taking the toy out of the other student's hand. Learning social skills and how to engage in positive interactions with peers is an important part of the socialization process (Blanco, 2022).

General Education

There is empirical evidence to support that collaboration in typically developing children has positive effects on early education. More specifically, researchers have found a positive association with elementary aged students' collaborative skills, academic achievement, and their social competence (Ladd et al., 2014). Kato et al. (2012) studied the psychological effects of an activity for collaboration in high schoolers using LEGO blocks. The researchers required participants to work collaboratively with each other and measured their social skills and trust. The researchers had participants answer questionnaires before and after the activity and found that by having the students work together on a collaborative block creation, there were positive effects on social skills and trust towards other students, according to the questionnaire. Social skills are important when forming positive relationships with others (Kato et al., 2012).

Some researchers use the term *cooperation* interchangeably with collaboration, suggesting the terms are synonyms (O'Neil et al., 2004). Like collaboration, cooperation involves working towards a common goal. Cooperation is a fundamental aspect of human social interactions that begin to emerge in early childhood. Children as young as 3.5 yr old engage in cooperative behaviors, such as sharing and reciprocity (Lin et al., 2024). Interventions to improve cooperation have been used in early childhood through structured activities, such as math games, collective singing activities, and joint block-building games. Researchers have found that a cooperative constructive play intervention significantly enhanced cooperation in 5-6 yr old children in China (Lin et al., 2024).

Yuan et al. (2024) defined cooperation as a crucial social behavior in which two or more individuals work together towards a shared goal and usually by a *reciprocal exchange*. Reciprocal exchanges are to-and-fro behaviors between individuals (Yuan et al., 2024) or where a student's behavior is followed by the response of another person. Further, Veldman et al.

(2020) discussed that cooperative learning could lead to improved work behavior as it provides opportunities for students to practice their group work skills. The researchers studied the effects of cooperative learning on students in a comprehensive school reform program, called *Success for All.* The school program was a comprehensive school reform program that incorporated cooperative learning as the core element to improve social-emotional and cognitive outcomes. Other key elements included engaging reading and language curriculum, tutoring, and parent involvement. Instruction included extensive use of cooperative learning in pairs and small groups with required cooperative behaviors such as, "everyone participates" and "ask each other questions." Good teamwork was also rewarded through a point system and certificates. There were 168 first graders enrolled in *Success for All* schools and 144 participants who were not enrolled in those schools. To investigate the effects on cooperative learning, the researchers measured the participants' positive group work and negative group work. Positive group work included being on-task, engaging in collaborative discussions, not blocking, and demonstrating maintenance. Blocking behaviors included explicit attempts to block participation by refusal. Maintenance behaviors included speech or gestures to sustain the group interaction, such as asking "Do you agree?" Negative group behaviors included a lack of maintenance, blocking behaviors, uninvolved or completely off task behaviors, and off-task or disruptive talk. The results of the study demonstrated that participants in the *Success for All* program showed more positive group work and less negative group work, compared to the participants within the control schools. The findings suggest that cooperative learning may lead to improved group work in young students of ages 6 to 7 years old (Veldman et al., 2020). Collaborative learning is often used in general education but less frequently utilized with children who have intellectual disabilities (Wishart et al., 2007).

Special Education

Students with disabilities may lack the initiation to work or play collaboratively with other students and rarely exhibit cooperative social behavior (Downs & Smith, 2004). Individuals with autism generally lack reciprocal social and communication skills. Additionally, most do not seek enjoyment of activities with others, and further show deficits in cooperative social behaviors (Downs & Smith, 2004). Humphrey and Symes (2011) found that 11-year-old students with ASD engaged in more solitary behaviors and less time engaged in cooperative interaction with peers, compared to students with no disabilities and students with Dyslexia. Collaborative learning tactics may be rarely used with children with intellectual disabilities due to the assumption that there are metacognitive skills heavily involved in collaboration (Wishart et al., 2007). Collaborative learning may also be difficult for people with autism spectrum disorder. Difficulties with social interactions are often part of the characteristics of autism spectrum disorder and collaborative interventions may address such skills and enhance conversation skills, emotional perspective-taking, and friendships (MacKay et al., 2009). A groupwork intervention demonstrated significant gains in children and adolescents with ASD that targeted social interactions and understanding (Mackay et al., 2009). The groupwork intervention consisted of small and large group activities that were designed to address conversational skills, friendship skills, and perspective taking. Both parents and participants reported enhanced levels of social competence in their posttest questionnaire. A lack of collaboration may lead to issues both in academic success and in social skills in students' early development**.**

A collaborative puzzle game was used to develop collaboration and foster social skills in children with ASD. Pianesi et al. (2009) designed a collaborative puzzle as a tabletop interactive

activity. The game featured a set of interaction rules, called enforced collaboration. The puzzle pieces only worked if they pieces were touched together and dragged at the same time by two participants. The results of the study found that the collaborative game had a positive effect on collaboration in both children with and without ASD. The children in the study learned, in order to contact reinforcement, and play the game correctly, they had to work together. Meaning, the game likely established reinforcement for collaboration. Further, the students with ASD showed interactions that reflect difficulty with social interactions. If collaboration was not enforced for the children with ASD, they would be more likely to work independently and perhaps ignore each other (Pianesi et al., 2009).

1.3 Developmental Perspective

Early social skills

According to child developmental psychologists, one aspect of "school readiness" is a social component (Ladd et al., 2006). School readiness derives from the idea that 5-year-old children should be prepared to adapt to school needs, which includes academic, social, and emotional competencies. Further, there are social prerequisites that a student should acquire during preschool years to predict success for kindergarten readiness. The social and emotional development during early schooling has a relation to scholastic success (Ladd, 2003) and is closely linked to readiness for kindergarten, future learning, and achievement (Raver, 2002). According to Ladd et al. (2006), social-entry tasks include initiating peer and teacher interactions, exhibiting prosocial behaviors during activities with peers, and forming constructive and supportive relationships with peers and teachers. Research has demonstrated that young children who interact prosocially with classmates develop mutual friends and demonstrate higher peer acceptance, which serves as a mediator to school engagement and achievement (Ladd et al.,

1999). The development of early social skills is important for the establishment of collaborative skills, such as demonstrating verbal communication, listening skills, and orientation towards and awareness of peers.

Evidence suggests that children are more likely to make friends when dyadic play and shared interests are present and when children demonstrate the skills to establish these relational conditions (Ladd, 2005). Peer-mediated learning, such as peer tutoring, peer collaboration and cooperative learning have been used to promote student motivation and active learning (Ladd et al., 2014). Specifically, peer tutoring has been demonstrated to be a reliable intervention to increase and promote the generalization of social skills (Seo & Kim, 2019; Bowman-Perrott et al., 2014). Peer tutoring involves students helping other students learn academic content and subsequently promotes peer cooperation. Various studies have found that implementing peer tutoring in classrooms across various ages has positively supported social interactions (Bolich, 2001). Research shows that when students work collaboratively, rather than independently, they perform better academically (Fawcett & Garton, 2005). When investigating the effects of young children learning to collaborate on a problem-solving task, researchers found that children who collaborated collectively, obtained higher scores on the sorting task, than the children who worked individually. Ladd et al. (2014) correlated 212 elementary-aged student's ratings on collaborative skills with their peer group acceptance and achievement scores. The findings demonstrated that help-related skills (giving and requesting help) and communication skills substantiated their correlation in the study. Further, the study found a positive association between collaboration skills and achievement which supports that learning is enhanced when students can work productively with their peers in school (Ladd et al., 2014).

Joint intentionality

Communication is essential for a team to collaborate, coordinate actions, provide feedback, develop strategies, and make decisions (Fiore et al., 2017). Social communication often presents itself as a challenge for children with autism and is most evident during joint engagement (Panganibab & Kasari, 2023). Social communication deficits related to ASD include concerns with social-emotional reciprocity, such as engaging in joint attention (Krier & Lambros, 2020). Individual learning does not rely on joint attention, while collaborative learning involves stable joint attention with sustained shared focus and language development. Joint engagement gradually emerges so that 18-month toddlers sustain periods of engagement with others on a shared topic, with explicit communicative actions (Adamson et al., 2009). Joint engagement occurs when a child initiates or responds to multiple bids for joint attention. When a child shifts from joint attention to joint engagement, they can seamlessly shift their attention from an activity or object to a person (Raulston et al., 2024). Specifically, children with ASD spend less time engaging joint engagement than their typically developing peers (Bottema-Beutel et al., 2014). It has been proposed that joint engagement episodes play a significant role in bridging the gap between emotional communication and collaborative learning interactions in early infancy (Degotardi, 2017). Joint attention episodes involve shared experiences on activity and perceptual levels in an event of joint interest (Tomasello, 1999). Lastly, joint attention involves communicative characteristics in which young children can learn language in a natural social environment (Degotardi, 2017). There is a dynamic relation between joint engagement and language use; specifically, joint engagement improved markedly when toddlers begin to speak (Adamson et al., 2019).

Researchers have demonstrated that students who collaborate are able to solve problems more effectively (Kuhn, et al., 2014). Solving problems together and developing shared

understanding and goals require collaboration (Poysa-Tarhonen, 2021). If joint attention is not achieved, it is less likely for children to collaborate due to a lack of common ground or partner's perspective (Baker, 2015). Joint attention is seemingly necessary for social interaction and predicting productive collaboration (O'Madagain & Tomasello, 2019). Researchers studied integrated play group on joint attention in young boys with autism. The results of Zercher et al., (2001) found that participation in an integrated play group produced increases in shared attention to objects, symbolic play, and vocal verbal utterances for two autistic boys. Further, a systematic review on interventions to increase joint attention discussed that effectively teaching the topography of joint attention skills and gaze shifting and following may have collateral effects on language development and social interaction in children with autism. More specifically, seventy-eight percent of the studies found that peer-supported play led to increases in joint attention responses or initiations (White et al., 2011).

Collaborative work between peers provides a rich learning environment for students while evoking communication between peers. Successful collaboration has been said to involve mutual engagement and joint decision making (Roschelle & Teasley, 1995). Recent research has investigated the effects of social reinforcement in student learning (Tomasello, 2016) and more specifically, understanding the significance of collaboration with peers. However, there is still a need for more research examining the effects of reinforcement for collaboration with peers in education and identifying the source of reinforcement of the cusp (Tomasello, 2016).

Behavior analytic perspective

Social behavior is described as behavior of two or more people with respect to one another or in respect to a common environment (Skinner, 1953). From an evolutionary perspective, cooperation is necessary for constructing new levels of organization as human

society is based on cooperation (Nowak, 2006). Evolutionary biologists suggest that there are three characteristics to human evolution: cognition, culture, and cooperation (Hayes & Sanford, 2014). High levels of cooperation require skills for joint attention, social referencing and perspective taking. (Hayes & Sanford, 2014). Cooperation comes before behavioral processes underlying human language and cognition (Hayes et al., 2014). Relational frame theorists explain that concepts such as relating, orienting, evoking and motivating are rooted in cooperative behaviors (Barnes-Holmes & Harte, 2022). Behavior analytic intervention for young children with autism should focus on building necessary prerequisites and establishing reinforcers to increase appropriate play skills and social engagement. Teaching new play and social skills are often embedded in behavior analytic interventions, while goals often involve social communication (Raulston et al., 2024).

1.4 Verbal behavior developmental theory

Collaboration can be conceptualized as a verbal behavior developmental milestone. Verbal behavior development theory (VBDT) (Greer & Ross, 2008) was derived from Skinner's *Verbal Behavior* (1957) and has been used to explain early verbal development. VBDT has identified developmental cusps that are critical for accelerated learning and language acquisition. These often align with developmental psychology milestones, but VBDT focuses on the experiences one has that helps establish the necessary reinforcers to access those milestones. Said another way, VBDT focuses on the stimulus control involved in reaching milestones, or cusps. A cusp allows a student to contact new contingencies in their environment (Rosales-Ruiz & Baer, 1996). Once the stimulus control for cusps is acquired, students can learn new behaviors they could not learn before, learn faster, and learn by contacting reinforcement within their social environment that they could not contact before (Greer et al., 2017). For example, when a student

acquires the observational learning cusp, they can learn through observation and without direct contact with consequences, which increases their rate of learning.

Greer and Ross (2008) added to this concept that cusps can involve verbal behavior. VBD cusps include preverbal, listener, speaker, and social cusps. Preverbal foundational repertoires include orienting towards others' voices and faces, conditioned reinforcement for looking at 2D and 3D stimuli, and generalized matching. When individuals acquire the cusps of conditioned reinforcement for faces and voices, they develop an increased social awareness towards adults who speak or enter a room. Once these cusps are established, individuals can learn from instruction faster and require fewer instructional trials to master objectives (Maffei et al., 2014). More specifically, once children acquire conditioned reinforcement for 2D and 3D stimuli, they more readily attend to instructional stimuli and this typically results in improved learning of matching, tacting, and manding objectives. Cusps continue to expand across repertoires, such as listener and speaker behaviors and eventually develop more complex cusps such as, say-do correspondence, textual responses, and conversational units (Greer et al., 2017).

The listener repertoire is an important early VBDT repertoire to develop and includes discriminating phonemes and sounds in the environment (e.g., discriminating sounds emitted by a mother). Auditory matching is an important listener cusp that involves the correspondence of hearing speech sounds and saying them to produce accurate echoics. This cusp enables a student to discriminate between exemplars and non-exemplars of auditory stimuli. It is essential that the student demonstrates the hear-say correspondence before they can begin to discriminate stimuli. For example, the student should identify vocal sounds and words, such as "dog" and D-O-G as the same before they can identify "dog" and "cat" as different. The onset of this cusp results in accelerated learning as the student can learn to discriminate among sounds and do not need to

rely on visual cues when presenting discriminative stimuli. Discriminating sounds emitted by social partners is critical because if one cannot discriminate different sounds, they cannot respond to directions (Greer & Ross, 2008). That is, words cannot be discriminative stimuli for following directions until a child discriminates those sounds. For example, if a teacher says, "stand," the student must understand that the direction is not the same as "sit." For students to respond accurately to those directions, they must first discriminate between those words, The listener repertoire also consists of listener literacy which is a cusp that enables students to learn from spoken instruction without visual stimuli present. When a student develops this cusp, they can respond accurately and fluently to vocal verbal instructions and their responses are not controlled by what they see, but by what they hear. For example, a teacher can give the student the vocal directions, "Go to your cubby" and the student can follow the vocal direction without relying on physical or gestural prompts to respond. In other words, the stimulus control shifts from the visual stimulus to the auditory stimulus. Basic listener literacy is required for effective learning, as evident by a decrease in the number of learn units-to-criterion (Greer, 2005). Once students acquire listener cusps, they can begin to develop speaker responses and begin to more effectively alter their environment.

Speaker repertoires include echoics, tacts, and mands, and a component of Naming. A mand is a verbal behavior cusp that enables students to request and specify reinforcers under conditions of deprivation (Skinner, 1957). This can be considered *contract reinforcement* because it involves the speaker obtaining a reinforcer from another individual. For example, when a student does not have access to water or is under deprivation conditions, they can functionally mand for "water" to request for the desired item. The acquisition of independent mands marks a step towards independence and suggests the establishment of broad contract

reinforcement (Greer et al, 2017). Further, the onset of contract reinforcement is important as it results in accelerated learning when the student learns it is easier and more efficient to access reinforcers by speaking mands (Greer & Keohane, 2006). To flourish in school, children should build upon various verbal behavior developmental repertoires and acquire necessary cusps and capabilities (Greer & Ross, 2008).

The tact is a cusp that enables students to emit verbal operants under non-verbal stimulus control and is reinforced through social attention (Greer et al, 2017). This can be considered *contact reinforcement* because it involved the speaker contacting social reinforcers from another individual. The reinforcement transfers from vocal praise or prosthetic reinforcers to social reinforcement embedded in the tact function. An example of a tact is when a student turns to his peer and labels the animals they are playing with the reinforcement of social attention or a "Wow, cool!" from the peer. Such independent tacts suggest the establishment of broad contact reinforcement. Once students acquire listener and speaker cusps, they can begin to work towards more complex cusps, such as the joining of listener and speaker and social cusps. A conversational unit is a VBDT cusp that occurs when an individual says something to another individual and the speaker is reinforced by the response of the listener (Lawson & Walsh, 2007). Conversational units are directly reinforced by the listener who responds in the presence of a speaker (Greer, 1989). For example, person A says, "I like that blue toy car" and person B responds, "Me too, do you want to play with it next?" Person A then responds back, "Yes, I'd love to." In this scenario, person A emitted a speaker response only in the presence of the person B (as a listener). The speaker's behavior was reinforced by the listener's behavior, and both individuals acted as both a listener and a speaker (Greer, 2002). Conversational units are an

essential measure in social behavior (Greer & Keohane, 2006) and a hallmark of social behavior (Greer et al, 2017).

As students emit in higher order operants, they may contact social cusps in which reinforcement shifts towards peers. The social learning repertoire includes cusps, such as observational performance, observational learning, and audience control. Observational performance is the change in one's behavior from observation of the contingencies received by others. These behaviors include responses that are already in the individual's repertoire (Greer et al, 2006). For example, a student that demonstrates observational performance may learn to raise their hand when observing other students receive reinforcement for it. Similarly, observational learning of new operants is when new information is acquired by observation of other student's receiving instruction with consequences (Greer et al, 2006**;** Greer et al, 2024). Both observational learning and performance are social learning cusps that are important for learning in group-based instruction in classrooms. Observation is part of social contract which is a key aspect of verbal development. The observation repertoire plays a role in many observational cusps that alter learning and performance, including: emulation, imitation, learning names of things through observation (Greer et al., 2024). The literature supports that observational learning is relevant to language acquisition and development (Greer et al., 2024).

Conditioned Reinforcement

VBDT utilized Skinner's taxonomy of verbal operants to identify cusps and capabilities that allow students to contact new contingencies in their environment and learn in ways they could not prior (Greer & Ross, 2008). VBDT emphasizes the acquisition of language via establishing new reinforcers. By using operant and respondent processes to condition reinforcers, VBDT researchers have demonstrated success in conditioning a variety of new reinforcers that

then support new behaviors. Conditioned reinforcement is a core principle of behavior that allows behavior analysts to understand human behavior. Conditioned reinforcement can be established through operant conditioning or respondent conditioning. Conditioned reinforcement by operant conditioning involves strengthening a behavior by associating it with a positive reinforcement consequence. For example, operant conditioning can be used to condition books as a reinforcer. In this conditioning process, the teacher and student engage with a book together for a determined interval of time. At the end of the interval, if the student engaged with the book for the entire duration, the teacher reinforced the student for appropriately looking at the book before entering a test trial for the same interval of time (Nuzzolo et al, 2002). During this conditioning, the teacher does not pair praise throughout the interval but instead praises after the appropriate behavior has been emitted.

Pavlovian-learning principles underly conditioned reinforcement (Madden et al., 2023). Conditioned reinforcement by respondent conditioning or classical conditioning is the pairing of a neutral stimulus with a reinforcer, in which the neutral stimulus then acquires a reinforcing function (Madden et al., 2023). Any neutral stimulus could be conditioned as a reinforcer; however, the strength of the reinforcer is related to the immediacy of the pairing (Kelleher & Gollub, 1962). It is also important to consider the frequency of pairing, as typically, the more frequent the pairing, the stronger the reinforcing value. Kelleher and Gollub (1962) found the effectiveness of the reinforcer was directly related to the frequency of reinforcement occurring in the presence of the stimulus. Fantino (1998) described a hypothesis in which rate increase of responses is dependent upon the discriminative effects rather than the reinforcing effects. This theory proposed that the value of a stimulus is due to the discriminative stimulus and how much it changes the time until delivery of reinforcement, compared to the typical time until

reinforcement, regardless of the stimulus. Further, Fantino (2008) emphasized the importance of temporal contexts and the effects on preference for conditioned reinforcement. This literature is important to note in the context of VBDT cusps, which emphasizes the importance of establishing reinforcement. Behaviors can range from preverbal cusps, such as observing 3D stimuli and continue into more advanced social cusps, like reinforcement for collaboration. Within the cusps conceptualization of development, it is the establishment of new reinforcers that accounts for behavior change.

Conditioning reinforcers is important because once the child acquires such, it strengthens and maintains relevant behaviors (Greer, 2020). Establishing new conditioned reinforcers also increases student's rate of learning when acquiring new and related operants (Gentilini & Greer, 2020). For example, tacts are expressive labels of things in the environment that are maintained by praise and attention from others; but praise and social attention must function as conditioned reinforcers before tact instruction can be successful. By establishing new conditioned reinforcers, individuals also acquire cusps and capabilities, such as conditioned reinforcement for correspondence between see- do (Du & Greer, 2014), conditioned reinforcement for observing faces (Maffei-Lewis et al., 2014), conditioned reinforcement for voices (Choi & Greer, 2014), conditioned reinforcement for observing books (Tsai & Greer, 2006), and conditioned reinforcement through observation (Greer & Singer-Dudek, 2008). Reinforcement for collaboration is an example of a developmental cusp in which students come into contact with contingencies and reinforcers that are social and not individual (Greer & Ross, 2008). VBDT researchers have identified these milestones necessary for language development and the implications of such in school. See Appendix A for VBDT cusps, and specifically the social learning cusps.

Group Contingencies

Group contingencies have been used extensively in education settings as they are said to be economical and feasible (Hayes, 1976). Researchers have demonstrated that classrooms that implemented group and individual consequences with rules and feedback was more effective in increasing appropriate behaviors compared to classrooms with just rules, and rules with feedback. (Greenwood et al., 1974). Implementing group contingencies is a feasible way to intervene on student behavior and increase academic engagement during group instruction (Cariveau & Kodak, 2017). Further, the literature suggests that setting up group contingencies in a classroom involve selecting target behaviors, choosing groups, deciding how behaviors earn points, and how points will be awarded (Chow & Gilmour, 2016). Group contingencies have been found effective for improving student academic and social outcomes as they can modify teacher behavior, increase teachers' attention to, and praise of appropriate student behaviors in the classroom (Barrish et al., 1969).

Group contingencies are said to foster interdependence and promote student's cooperative behaviors because the behaviors required to earn the reinforcer are inherently cooperative (e.g., working together) and the reinforcer is social (e.g., children earn something together) (Pigott et al., 1986). Group contingencies include dependent, independent, and interdependent (Cooper et al., 2020). Dependent group contingencies are when reinforcement is delivered to the entire group only if one person in the group emits the correct behavior. This type of contingency is also known as the "hero" contingency as one individual's behavior earns reinforcement for the entire group (Cooper et al., 2020). For example, a teacher may reward an entire class with candy if a specific student receives an A on the exam. Independent group contingencies deliver reinforcement to all members of a group who emit specific behaviors. For

example, all the students who stay in their seat during the math lesson earn a point while any student who gets out of their seat during that time, does not earn the point. Lastly, the interdependent group contingency is used to provide reinforcement to an entire group only if every individual within the group emits the correct behavior. This type of contingency promotes peer influence, encouragement, and support from members of the group, suggesting a relation to collaboration. However, not everyone's behavior may be sensitive to group contingencies and these individuals may require intervention to learn that group contingencies can be reinforcing.

Promoting Collaboration

Researchers have studied a variety of different interventions to improve collaborative behaviors. Barrish et al. (1969) used an interdependent group contingency, also known as the good behavior game, to decrease disruptive behaviors in fourth grade classrooms. The students were split into two "teams" with the contingency that any individual who emitted an out-of-seat or talking-out response, received a mark on the chalkboard for their team. If a team had fewer marks or neither team received more than 5 marks, then the team would receive reinforcement such as victory tags and free time while the team who lost the game would not receive any reinforcement. The results of the study demonstrated that disruptive classroom behaviors decreased after the group contingency was implemented. Interdependent group contingencies ensure that group members all are required to emit specific and goal-directed behavior to receive reinforcement. Additionally, the reinforcer is consumed socially as opposed to individually. Interdependent contingencies have been described as effective in classrooms to manage large groups and can be more time efficient than independent and dependent group contingencies. Because the reinforcement is delivered in an all or none fashion to a group, students may also demonstrate more social cooperative behaviors (Skinner et al., 1996). Interdependent group

contingencies are frequently called the most ideal group contingency for its inclusion of cooperative arrangements that employ response-sharing procedures (Carriveau et al., 2020).

Yoked contingencies are interdependent contingencies, specifically with two individuals whose collective behavior constitute that which is being reinforced. Yoked contingencies were developed to arrange contingencies in a manner that requires two individuals to collaborate and emit specific actions toward some common goal that results in a shared reinforcer (Geer & Du, 2015). Peer-yoked contingency game boards are a tactic used to reinforce the collective behavior of two individuals. This means that when both peers respond correctly, they move up on the game board together, and therefore reinforcement is yoked to collective behavior, rather than individual behavior. This tactic also established motivation among students to reinforce peer's correct behaviors and move up on the game board (Rothstein & Gautreaux, 2007). Stolfi (2005) and Davies-Lackey (2005) used a peer-yoked contingency to examine observational learning in preschoolers with disabilities. The researchers used a game board with two teams with corresponding paths and wining spaces. For the participants to move up on the game board as a team, the target participant was required to emit a correct response for an observed learn unit. If the participant emitted an incorrect response, the experimenter's team moved up on the game board. The winning team's behavior contacted reinforcement while the losing team's behavior did not. The results demonstrated that a peer-yoked contingency game board was effective in establishing observational learning for young children with disabilities.

Peer Tutoring

Peer tutoring has demonstrated positive effects on children's academic achievement and peer interactions (Greenwood et al., 2002). Peer tutoring is an instructional tactic used in classrooms where children function as teachers to teach each other academic and social

behaviors (Lawson & Trapenberg, 2007). When students work together to accomplish shared goals, they demonstrate improvements academically and socially (Bourdouris, 2005). Peer tutoring can be an effective strategy to benefit different ages and abilities, including students with diagnosed learning disabilities, autistic children, typically developing children, and English-language learners (Boudouris, 2005). Literature supports that peer tutoring has been particularly beneficial for students with a social disadvantage and who have special education needs (Thurston et al., 2021). During peer tutoring, positive interactions between tutor and tutees increase while negative social interactions decrease (Scruggs et al., 1985). Lawson and Trapenberg (2007) studied the effects of peer tutoring of teaching social studies to third and fourth grade students. The researchers measured the participants' social interactions during unstructured free time. The researchers found that individual and class-wide social approvals increased while disapprovals decreased during free time, following the implementation of peer tutoring. That is, as children learned how to engage in peer tutoring, their prosocial behaviors toward each other improved outside of peer tutoring. Similarly, a study examined the effects of peer tutoring on young children's social interactions. The researchers found that a class wide peer tutoring intervention was effective for increasing social interactions for both English-language learners and children who spoke primarily English (Xu et al., 2008). Research also supports that peer tutoring has positive effects on academic achievement across various grade levels. A study found significant increases in academic achievement for undergraduate students in a peer tutoring group compared to students who did not engage in peer tutoring (Comfort & McMahon, 2014). In 2018, Ullah et al. conducted a study to measure the effects of peer tutoring on academic achievement of 110 male students in 10th grade learning biology. The results

demonstrated that participants in the experimental group performed better than students in the control group on academic achievement in a biology course.

Peer tutoring also has shown success in young children in elementary school. Peer tutoring was implemented in a second-grade classroom to teach spelling words. In Lundberg et al (2022), the researchers alternated teacher-led and peer tutoring spelling instruction and measured students' accuracy and fluency. The results showed that peer tutoring for spelling led to better performance and was more acceptable to the students in this study**.**

Peer tutoring has been widely used to increase student's academic performance and social behaviors. Lawson and Walsh (2007) implemented a social listener reinforcement (SLR) protocol to target the development of the reinforcement component of speaker and listener exchanges in elementary school students with autism. SLR is a unique, arbitrary selection of activities in which children's reinforcement is yoked together. SLR has been used previously to increase vocal verbal operants and social behaviors with peers (Sterkin, 2012; Baker, 2014). However, no other studies have demonstrated that children can learn faster in collaborative contingencies following the SLR procedure.

Social Listener Reinforcement

In the SLR protocol, individuals in a yoked contingency are required to work together to respond correctly to access reinforcement (Greer & Ross, 2008). Lawson and Walsh (2007) taught elementary aged participants diagnosed with ASD to use verbal behavior to interact with their peers and to contact social reinforcement in their environment through SLR. The protocol consisted of various phases including, "I-Spy, "20 questions," "peer tutoring," and "group instruction with the game board" that taught and reinforced conversational units between peers. During each phase of intervention, there was a yoked-contingency game board present in which

the participants were yoked together to contact reinforcement, meaning, when both participants responded correctly, their game board piece was moved up on the board. If either of the participants responded incorrectly, the researcher's game board piece would move up because the collective participant response was incorrect. Therefore, the participants' responses were yoked together, and their collective reinforcement was contingent upon their collective behavior. Results of the study suggested that the participants developed the reinforcement component of the speaker listener exchange as evident by an increase in the number of conversational units emitted in a play area.

Additionally, Sterkin (2012) tested the effects of SLR protocol on audience control in preschoolers with developmental delays. The researcher found that through conditioning social reinforcement, the participants demonstrated increased social interactions with their peers. Social reinforcement was defined as delivering vocal praise, attention, or physical interaction. (Tsouri & Greer, 2007). Social reinforcement must be present for children to engage in conversational units with one another. The SLR protocol functioned to increase conversational units between peers and increase the initiation of social vocal operants to peers (Sterkin, 2012). When social reinforcement is missing, individuals do not emit verbal operants maintained by social reinforcers (Baker, 2014). Baker (2014) examined the effects of SLR on verbal operants emitted by preschoolers with ASD, and speech and language delays. Baker (2014) used the SLR protocol to reinforce participants for responding to peers' speaker behaviors by completing listener and speaker exchanges, or conversational units. The SLR protocol included phases such as I-Spy and peer-tutoring but also included a collaborative construction of blocks. The collaborative construction was designed to teach participants to engage in conversational units when constructing a puzzle together. The results found that participants increased the number of peer-

initiated verbal operants they responded to and decreased the number of missed opportunities to respond. Through the SLR protocol, listening to peer's verbal behavior became a conditioned reinforcer.

1.5 Rationale for Experiment 1

There is a great need for establishing reinforcement for collaboration for students with disabilities (Cook & Friend, 2010). Although research has found collaboration to be important in children's development, there has been little research to address the important of reinforcement for collaboration on preschoolers with disabilities. However, a study was conducted examining the effectiveness of a cooperative play intervention on cooperative behaviors in 4-7-year-old children with autism spectrum disorder (Yuan et al., 2024). The intervention consisted of the participants constructing models together using toy sets. The results demonstrated that the cooperative play intervention increased cooperative behaviors and generalized across three novel toy sets. Cooperative play is a type of play in which children engage in activities together, working collaboratively towards a shared outcome. Research has also pointed out the positive outcomes of collaboration on students with disabilities' social outcomes (Skopeliti & Riga, 2021). When children engage in collaborative learning, they connect with others, which fosters social support and a learning community. Skopeliti and Riga (2021) state that there are positive effects associated with collaborative learning in special education that help students achieve cognitive, social, and emotional goals. Children with special education needs benefit from collaborative learning techniques in academic activities and show improvement in social domain as they acquire communication skills (Skopeliti & Riga, 2021).

In an unpublished dissertation, Darcy (2017) conducted research examining establishing the appropriate reinforcement for collaboration on elementary-aged students' rate of learning.

The researcher compared the rate of learning as measured by learn units-to-criterion under a peer-yoked contingency and an individual condition. Seven of the twelve students learned faster under the collaborative reinforcement condition, suggesting the conditioned reinforcement for collaboration cusp was present. For the students who did not demonstrate the cusp, the researcher implemented a collaborative intervention to establish the cusp for the remaining students and measured their rate of learning under both conditions and number of vocal operants. The vocal operants were measured as the number of telling a peer the answer, asking for or offering help, sequelics, tacts, conversational units, approvals, disapprovals with peers.

The collaborative intervention consisted of peer tutoring in which participants were paired with peer confederates and served as both tutors and tutees. The peer-yoked contingency was present during the intervention in which both students were required to collaborate to move up their piece on the game board and earn a backup reinforcer. During the procedure, the tutor was required to deliver a correct learn unit to the tutee such that the antecedent was delivered correctly, an opportunity was presented for the tutee to respond, and the tutor delivered contingent reinforcement. When the learn unit was intact this was considered correct collaborations and the students could move their game piece up, however, if the tutor did not deliver an intact learn unit or the tutee responded incorrectly, then the researcher got to move up their piece on the game board. In Darcy's (2017) study, the findings suggested that collaborative peer tutoring may have established reinforcement for collaboration for typically developing early-elementary-aged students.

Educational and developmental literature supports the need for collaboration, however, there is little empirical evidence from a behavior analytic perspective (Laal & Laal, 2011; Ladd et al., 2015). Therefore, more research should be conducted to answer theoretical and practical

questions regarding the effects of establishing reinforcement for collaboration on young children's academic, social and communicative repertoires. Although Darcy (2017) measured the effects of establishing reinforcement for collaboration on rate of learning and expressive speech within instructional settings, there are still empirical questions to be answered, such as the effects in non-instruction settings and broader changes in social skills. The current study aimed to investigate the presence and effects of reinforcement for collaboration in preschoolers classified with disabilities and further investigate the participants' collaborative behavior during noninstructional settings. According to literature, teaching children to collaborate and play together leads to more joint attention (White et al., 2011). Peer tutoring has also demonstrated positive effects on academic performance and social skills, however, researchers has not targeted collaborative behaviors between peers. Therefore, there is still a need for more research on the effects of young children collaborating. The purpose of this study is to induce the VBDT cusp of reinforcement for collaboration in preschoolers classified with a disability and investigate both the academic and social implications. To establish collaboration as a reinforcer, the researchers will use multiple collaborative activities (e.g., I-Spy, peer tutoring) to strengthen the reinforcement for collaboration with peers. Through this intervention, the children will contact reinforcement for collective and collaborative behavior across multiple collaborative activities, that require equal participation to complete a task successfully. The sequence of the intervention was designed to build up the participants' communicative and collaborative behaviors and eventually, have the students produce collaborative behaviors. For example, in the first phase, "I-Spy," the participant learns to respond as a listener to the peer to emit a correct response. Then, in the second phase, "20 questions," the peer taught the participant the name of a new stimulus. During "peer tutoring," the participant and peer began to emit intraverbals to one another. In the

final phase, block construction, the participant has then learned to emit intraverbals, deliver learn units, and contact reinforcement through the peer-yoked contingency, to condition reinforcement for collaboration.

This study aimed to extend previous literature and answer the research question: Does the establishment of reinforcement for collaboration demonstrate effects on preschoolers with disabilities' rate of learning, collaborative behavior and vocal verbal behavior during a collaborative activity, and joint attention observing responses to peers?

Chapter 2: Experiment 1

2.1 Method

2.1.1 Participants

Three children with a mean age of 4.2 (range of 3.6 to 4.10 years old) participated in this study. Two of the participants were male and one was female. All the participants were educationally classified as preschoolers with disabilities. The participants all attended a Comprehensive Application of Behavior Analysis to Schooling model preschool 5 days a week for 5 hr per day. The participants learned objectives in academic, social, self-management, listener, and speaker domains. They received daily instruction individualized towards their prerequisites, mastered objectives, and long-term goals. Examples of instructional objectives included, direct instruction language and math curriculum, early-reader curriculum, dyad instruction, handwriting worksheets, independent worksheets, and teaching appropriate game play. Researchers selected these participants because they demonstrated little communication towards peers, difficulty sharing toys with peers, and engaged in mostly solitary play. Additionally, researchers selected these participants because they demonstrated a slower acquisition in a collaborative contingency learning condition compared to an individual contingency learning condition, suggesting that they lack the cusp of collaboration as a reinforcer. The rest of this paper will use collaborative contingency and individual contingency to tact the learning conditions used in the learn unit-to-criterion assessment. The learn unit-to-criterion assessment is described in more detail below. Three peers with a mean age of 4.4 (range of 4.2 to 4.6) participated as peers in this study. The researcher selected the peers because they demonstrated reinforcement for collaboration. See Table 1 for participant and peer demographics.

Table 1

Participant Demographical Information

	Participant A	Participant B	Participant C	Peer A	Peer B	Peer C
Age	4.1	3.6	4.9	4.8	5.1	5.1
Gender	Female	Male	Male	Female	Male	Male
Disability	Preschooler with a disability	Autism Spectrum	Preschooler with a disability	Preschooler with a disability	Preschooler with a disability	Preschooler with a disability
Race	Black	Hispanic	Black	Black	Black	Black
VBDT Cusps	Conditioned reinforcement for 2D & 3D stimuli, voices and faces, mands, tacts, Inc-BiN for familiar stimuli	Conditioned reinforcement for 2D &3D stimuli, voices and faces, mands, tacts, Inc-UniN for familiar stimuli	Conditioned reinforcement for 2D &3D stimuli, voices and faces, mands, tacts, Inc-BiN for familiar stimuli	Conditioned reinforcement for 2D & 3D stimuli, voices and faces, mands, tacts, Inc-BiN for familiar stimuli	Conditioned reinforcement for 2D &3D stimuli, voices and faces, mands, tacts, Inc-BiN for familiar stimuli	Conditioned reinforcement for 2D &3D stimuli, voices and faces, mands, tacts, Inc-BiN for familiar stimuli

2.1.2 Setting

Both assessment and intervention sessions occurred in the classroom that the participants attended, located in a suburb about 25 miles from a large city. The preschool utilizes behavior analytic principles and verbal behavior development theory (VBDT) (Greer & Ross, 2008) to develop curriculum and design instruction. The school is a data-driven, research-based system that creates individualized instruction, uses continuous measurement, assessment and graphic display of student success (Singer-Dudek et al., 2010; Singer-Dudek et al., 2021). The self-contained classroom consisted of a teacher-student ratio of 12:1:2 (12 students, 1 teacher and 2 teacher assistants). The students in the 12:1:2 self-contained classroom demonstrated pre-verbal, listener, and speaker VBDT cusps. They also demonstrated strengths in early preschool academic curriculum and were early reader and writers. However, the students demonstrated self-management needs and social and behavioral needs that were targeted daily through behavior tactics and individualized programming. The collaborative activity assessment was conducted on the floor in the hallway right outside of the classroom or in the corner of the classroom on the floor, away from tables, chairs, and other students. The learning and joint attention assessments were conducted in the classroom at the participants' table. The intervention was also implemented inside the classroom at the participants' table.

2.1.3 Materials

In the individual contingency learning condition, stimuli were presented on Google Slides slideshow on a Mac laptop or on an iPad. The slideshow consisted of 20 slides for each child. For the children who learned to spell novel sight words, the iPad screen contained letter tiles, which included the correct exemplars needed to spell the word, with the addition of two non-exemplar letters. For example, if the target word was *people*, the necessary letters would be

present, along with unnecessary letters such as *m and u.* For the children who learned to tact novel pictures, the iPad screen contained the picture of the stimulus. There were four slides for each stimulus that were presented in a rotated order. The collaborative contingency learning condition consisted of the same materials, with the addition of a peer-yoked contingency game board. The game board consisted of two 215.9 x 279.4 mm computer papers glued together and laminated with two rows of 20 Velcro spots leading to the top. The game board also had two dinosaur or princess characters that moved up on the board, one piece representing the participants and the other piece representing the researcher. See Figure 1 for a picture of the contingency game boards. See Table 2 for stimuli used during the learning assessments. See Table 3 for stimuli used during phases of intervention.

Figure 1

Contingency Game board

Table 2

Stimuli Used in Learn Unit to Criterion Assessment

	Set A	Set B	Set C	Set D	Set E	Set F	Set G	Set H
Tacts	Laptop	Typewriter	Comet	Jupiter	Geyser	Marshes	French Press	Crockpot
	Blackberry	PlayStation	Saturn	Mercury	Plateau	Hills	Sifter	Fryer
	Puffin	Fax machine	Tornado	Uranus	Condor	Oasis	Mixer	Yacht
	Caribou	Musk Ox	Wildfire	Lightning	Heron	Pelican	Crane	ATV
	Lemming	Lynx	Flood	Hail	Parakeet	Swallow	Moped	Jet Ski
Spelling	And	Funny	Play	Girl	Ride			
	Blue	Down	Two	Little	Also			
	In	Come	Yellow	Number	Mother			
	Help	Find	Me	Equal	City			
	For	Here	Away	Over	People			

Table 3

Stimuli Used in Intervention

Phase 1: I-Spy	Phase 2: 20 questions	Phase 3: Peer tutoring Set A	Phase 3: Peer tutoring Set B	Phase 4: Block tower construction
Circle	George Jetson	Trumpet	Saxophone	10 various color building blocks with one or two prongs
Square	Porky Pig	Bongos	Clarinet	
Heart	Road Runner	Harp	Shaky Eggs	
Triangle	Bugs Bunny	Xylophone	Recorder	
		Flute	Violin	

During the collaborative activity assessment, the researcher used various floor puzzles ranging from 20-40 puzzle pieces, an iPad to video record the session, and a timer. See Table 4 for the vocal verbal operants (VVOs) and definitions. During the Early Learner Curriculum and Achievement Record (ELCAR) (Greer et al., 2023) and Childhood Joint Attention Rating (C-JARS) assessments (Mundy et al., 2017), the researchers used the given data sheet and a pen. See Tables 4 and 5 for lists of ELCAR and C-JARS items.

During the intervention, the researchers presented the picture stimuli on Google Slides slideshow on a Mac laptop or iPad. In each phase of intervention, the slideshow consisted of 20 slides. Both Phases 1 and 2 consisted of 2 stimuli, which were presented on 10 slides for each stimulus that were presented in an alternating order. In Phase 3, there were 5 stimuli, which were presented on 4 slides for each stimulus and presented in an alternating order, for the participant and the peer. In the last phase of intervention, there were two sets of ten Lego blocks, two clipboards, and two coordinating-colored pictures of a constructed Lego block tower on an 8x10 in computer paper. There was also the same peer-yoked contingency game board used in the collaborative contingency learning assessment.

2.1.4 Measurement

There were four dependent variables: the participants' learn units-to-criterion on a learning task under two different contingencies (i.e., collaborative contingency and individual contingency), collaborative behaviors and VVOs emitted during a collaborative activity, ELCAR assessment of joint attention observing responses, and the C-JARS. During the learn unit-to-criterion assessment, the researcher recorded a plus (+) if the participant emitted the correct spelling or tact response and a minus (-) if the participant emitted the incorrect spelling or tact response, or no response within 5 s. Learn units-to-criterion (LUC) was the number of

instructional trials required to meet the mastery criterion of 90% or above across two consecutive sessions. The researcher calculated LUCs separately for the collaborative and individual contingency conditions. Lower LUCs indicates faster, or more efficient, learning.

During the collaborative activity assessment, collaborative behavior was defined as instances of passing a puzzle piece to the peer, accepting a piece from the peer, requesting a piece, requesting help from the peer, or placing the puzzle pieces together. To measure the collaborative behaviors during the collaborative activity, the researchers used partial interval recording for 5 min with 5 s intervals, the researcher recorded a plus (+) if the participant engaged in any collaborative behaviors or recorded a minus (-) if the participant did not engage in collaboration. During the same activity, the researcher used event recording to tally VVOs emitted. VVOs included echoics, mands, tacts, intraverbals, and conversational units emitted towards peers. See Table 4 for descriptions of each VVO. At the end of the session, the researcher summed the intervals with collaboration and the number of each VVO. During the ELCAR joint attention observing responses assessment, the researcher recorded a plus (+) if the participant emitted a behavior towards a peer and a minus (-) if the participant did not emit the behavior during the session. See Table 5 for definitions of each context and behavior observed. At the end of the assessment, the researcher summed the total of correct responses, with a maximum of 4 opportunities to respond correctly.

Table 4

Vocal Verbal Operant Assessment Definitions

VVO to Peer	Definition	Example
Echoic	A vocal response with point-to-point correspondence with a verbal stimulus.	One student says, "bus" and the other student says, "bus."
Tact	Student comes in contact with a stimulus in environment, and names it, which is consequated with attention from a listener.	Finds a bus on a puzzle piece and says, "a bus!"
Mand	Request to acquire or terminate a stimulus	Says to peer: "Can you pass the bus please?"
Intraverbal	A vocal response in response to vocal verbal behavior with no point-to-point correspondence	Peer says, "Here is the bus" and other student says "Thanks!"
Conversational Units	An exchange between individuals in which each person acts as a listener and speaker at least twice	Student A says, "Pass the bus piece." Student B says, "Here you go. Can you pass the train piece? Student A says, "Thanks, it goes here." Student B says, "I can connect it!"

Table 5

ELCAR Joint Attention Observing Responses

Behavior	Definition
2-point orienting with gaze shift and pointing initiated by peer	Peer points to an object while turning to look at it, and the target child orients toward it
2-point orienting with gaze shift initiated by peer	Peer turns and looks at object/stimulus in the environment and target participant orients towards it
3-point orienting with gaze shift/pointing initiated by peer	Peer points to an object while turning to look at it, and the target child orients toward it and then back towards the peer
Initiated joint attention with peer	The target child points or looks towards an object to get a peer to also orient towards it

Note. These observing responses were taken from the ELCAR (Greer et al., 2023)

During the C-JARS assessment, the parent and classroom supervisor independently rated the participants' social behaviors on a scale of 0 (Never) to 4 (Always). Asocial items included items such as: "talks to others without looking at them" and "has difficulty maintaining a back-and-forth conversation with others." Prosocial items included items such as: "works cooperatively in groups" or "shares exciting events that happened at school." Once the researcher collected the surveys, the researcher used a scoring rubric to determine the participants' clinical level of joint attention development. The researcher calculated the participants' prosocial score, asocial score, and summary score. To calculate prosocial and asocial scores, the researcher summed the items that reflected prosocial behaviors and asocial scores and then divided the number by the number of items accordingly. To calculate the summary score, the researcher subtracted the asocial score from the prosocial score. Birkeneder et al. (2024) examined the validity of social and prosocial scales in school-aged children with ASD and typically developing children. The results indicated that the C-JARS was sensitive and specific to characteristics of children with ASD, such as joint attention and shared experiences.

The intervention had four phases with different expectations for correct and incorrect responses. The researcher recorded a plus (+) if the participant and the peer engaged in a correct response. For example, in I-Spy phase, a correct response was determined if the participant asked the peer what the stimulus was, the peer told them the correct response, and the participant retold the researcher the correct response. If the participant and peer did not engage in that procedure or did not emit any response within 5 s, the researcher recorded a minus (-). See Table 6 for definitions of correct and incorrect responses for each phase of intervention.

Table 6

Intervention Phase Response Definitions

Phase	How to Play	Correct Response	Incorrect Response
I-Spy	Only peer saw the stimulus. Participant asked, "What is it?" to the peer and the peer told him/her the answer. Participant told the researcher the answer.	The participant told the researcher the correct response.	The participant did not tell the researcher the correct response or did not respond within 5 s.
20 questions	Same as above, but both children saw the stimuli. Only the peer knew the name of the stimuli.	The participant told the researcher the correct response.	The participant did not tell the researcher the correct response or did not respond within 5 s.
Peer tutoring	Participant showed peer a stimulus and asked, "What is it?" and waited up to 5 s for a response (alternated each child).	The participant said correct name of picture and the peer delivered praise (and vice versa).	The participant said incorrect name of picture or did not respond within 5 s, or the peer did not reinforce or deliver error-correction accordingly
Block tower construction	The participant had picture of block tower and peer had the corresponding blocks. Participant told the peer which block to place by describing color and number of prongs (until 10 blocks are built, then switched where peer taught participant).	The participant told peer the correct block to place, AND the peer selected/placed correct block (and vice versa).	The participant told the peer the incorrect block, the peer selected/placed incorrect block, or the peer did not respond within 5 s.

2.1.5 Procedure

Pre-Intervention Assessments

Learn Units to Criterion. The researcher assessed the learn units-to-criterion for acquiring novel spelling or tact responses across two separate contingency conditions: individual contingency and collaborative contingency. Dyads A and B received tact instruction, and Dyad C received spelling instruction. During both contingencies, two children worked with a researcher. The researcher rotated presenting learn units between the children (participant and peer). When the participant or peer emitted a correct response, the researcher delivered vocal praise to the specific child. If one child emitted an incorrect response or did not respond within 5 s, the researcher delivered an error-correction procedure to that individual. For the error correction procedure for spelling responses, the researcher said, "Spell __" and modeled moving the letter tiles to demonstrate the accurate spelling. The researcher then moved the letter tiles back into the original placement and once again said, "Spell ___" and provided the participant an opportunity to independently emit the spelling response. For the error-correction procedure for tact responses, the researcher said, "What is it?" and then said the correct name of the picture. The researcher then asked the participant again, "What is it?" and provided the participant an opportunity to independently emit the tact response. After the error-correction procedure, the researcher did not deliver any praise. Once one child received either reinforcement or a correction procedure for their response, the researcher turned to the other individual in the dyad and delivered the same instructional sequence to them. The researcher then rotated back-and-forth between each child until they each spelled or tacted the entire set of instructional stimuli. Once the participants completed their instruction, the researcher delivered a reinforcer individually to each child.

Prior to the individual contingency learning sessions, the researcher asked the children what each participant wanted to earn after each completed their work. Typical reinforcers included fruit snacks, a video on an iPad, or time in the toy area. Once the session was complete, the researcher delivered individualized reinforcers to each child.

During the collaborative contingency, a peer-yoked contingency game board was taped on the wall in front of the children. The alternating learning procedure was delivered in the same manner as the individual contingency with individual consequences for correct and incorrect responses to each child. However, during this condition, there was a peer-yoked contingency game board present. When either of the children emitted a correct response, the researcher moved the game board piece up on the game board. If either of the children emitted an incorrect response, the researcher moved her game board piece up the board. This procedure continued until both children received twenty learn units each. After the session, if the children reached the top of the game board, the researcher delivered a shared reinforcer that the children earned together. Examples of shared reinforcers included playing dress-up together or novel "special" toys that were played with together (e.g., novel board games or an iPad game together). If the researcher reached the top of the game board, the participants did not receive the shared reinforcer and was instructed, "You can try again tomorrow!"

Collaborative Activity with an Embedded Verbal Operant Assessment. During the collaborative activity, the researcher told the participant and the peer to come over to the hallway and said, "You friends are going to do a floor puzzle!" The researcher then set up the iPad so that the camera faced the participant and the peer on the floor and the researcher gave them the floor puzzle. The researcher recorded the participant and the peer engaging with the puzzle for 5 min. Once 5 min elapsed, the researcher said, "That was fun, let's clean up now!" The researcher then

watched the video and measured the participants' number of collaborative behaviors and frequencies of vocal verbal operants emitted.

Joint Attention. During the ELCAR assessment, the researcher sat directly next to the participant and recorded the participants' observing responses emitted towards a peer. See Table 5 for the behaviors observed and examples of correct responses. The researcher did not provide any reinforcement or corrections after the participants' responses. Once the assessments were conducted, the participant resumed back to regular instruction. During the C-JARS assessment, the researcher gave the classroom supervisor and parents the printed scale to fill out independently, prior to the start of intervention and again at the end of intervention.

Intervention

During all phases of intervention, the participant and the peer sat next to each other and in front of the researcher. The researcher first asked the children what they wanted to earn if they made it to the top of the game board and assisted in choosing a shared item, game, or activity. Through all phases of intervention, if the participant emitted the correct response, the researcher delivered vocal praise to both children and respectively moved up their game board piece on the board. If the participant emitted an incorrect response or did not respond at all within 5 s, the researcher delivered an error-correction procedure and respectively moved the researcher's game board piece up the board. The procedure continued for the 20 learn units. During all phases of intervention, if the children's game board piece reached the top of the game board, or met mastery criteria of at least 90% accuracy, the researcher reinforced their behavior with their pre-selected, shared reinforcer. If the researcher reached the top of the game board before the children, or they did not reach criterion level, the children did not receive their pre-selected

reinforcer. The researcher then said, “You can try again tomorrow!” The mastery criterion to proceed to the next phase of intervention was 90% accuracy across three consecutive sessions.

In Phase 1, “I-Spy”, the researcher set up the iPad so that the peer could see the screen, but the participant could not. The researcher first taught the children the rules of the game by explaining to the participant that he or she needed to ask their peer what was on the screen and then tell the researcher. The researcher presented only the peer with the iPad that displayed the stimulus and said to the participant “What is it?” The participant was not able to see the iPad screen throughout the session. The participant then turned to the peer and asked them what the stimulus was. The peer then told the participant who turned back to the researcher and said the name of the stimulus. Once the participant emitted a response, the researcher delivered reinforcement or an error-correction procedure.

During Phase 2, the researcher implemented a 20-questions game. Prior to the beginning of the second phase of intervention, the researcher taught tacts of two cartoon characters to the peer until they demonstrated mastery of 100% accuracy within one session. The researcher also assessed whether the participant knew the names of the cartoon characters before proceeding, to ensure that they were not already in their repertoire. During this phase, the researcher set up the iPad so that the peer and participant could both see the stimuli. The researcher presented the stimulus on the iPad and said to the participant “What is it?” The participant then asked the peer what the stimulus was. Next, the peer told the participant the answer, then the participant looked back at the researcher and said the name of the stimulus. Once the participant emitted a response, the researcher delivered reinforcement or an error correction procedure.

During Phase 3 of intervention, the participants engaged in peer tutoring. Prior to beginning of this phase intervention, the researcher taught the participants how to deliver

antecedents and consequences. The researcher told the participant that they were going to teach the researcher the names of different animals. The researcher told the participant to hold up a known animal toy and ask, “What is it?” The researcher then modeled both correct and incorrect responses with various animals and taught the participant to say “Good job” if it was correct or say the name of the animal if the response was incorrect. The researcher continued practicing learn units with the participant with 10 opportunities to reinforce the researcher and 10 opportunities to provide an error-correction procedure, for a total of 20 learn unit sessions. The researcher continued to run peer tutoring prerequisite sessions with the participant until they demonstrated 100% accuracy in delivering learn units to the researcher within one session.

Additionally, the researcher taught the names of five different instruments to both the participant and peer using tact instruction until they demonstrated 100% accuracy within a session. Once the participant and peer both mastered their individual sets of instrument stimuli to teach, the third phase of intervention, “peer tutoring” began. During this phase, the researcher handed each student an iPad with their respective stimuli to teach. The researcher instructed the participant and peer that they were going to teach each other the names of instruments. The peer first presented the participant with the stimulus and said, “What is it?” The peer waited up to 5 s for the participant to respond. If the participant responded correctly, the peer said, “Great job!” If the participant responded incorrectly, the peer said the correct name of the stimulus and did not provide any praise. If both the participant and peer emitted the correct response, the researcher delivered vocal praise to both students and respectively moved up their game board piece on the board. If either of the children emitted an incorrect response or did not respond at all, the researcher delivered a correction and respectively moved the researcher’s game piece up the board. The procedure continued for a total of forty trials (20 for each student).

The fourth phase of intervention was a collaborative block tower construction task. During the collaborative block construction, the researcher handed the participant and peer each their own bag of blocks and a picture of a built tower clipped to a clipboard. The researcher instructed the participant and peer to hold their picture close to them and not let one another see the picture. The researcher then explained the rules to the students in which they would each have a turn at teaching each other how to build a tower, without seeing the structure. The researcher instructed the peer to tell the participant what block to put first. The participant then selected the corresponding block that was said and placed it on the table. This continued for 10 blocks until the tower was complete. For example, "put the one blue block on top." After each block was chosen correctly and placed correctly on the structure, the researcher delivered vocal praise and moved up the student's game board piece. If either an incorrect block was placed or the peer told the participant to place the wrong block, then the researcher provided an error-correction procedure and moved up the researcher's game board piece. The procedure continued for 10 trials until the participant completed the block tower and then the researcher turned to the participant and said, "Now it is your turn to teach how to build your tower." The researcher then gave the peer their bag of blocks and the participant their corresponding picture. The same procedure continued for another 10 trials until the participant taught the peer how to construct their block tower, for a total of 20 trials.

Post-Intervention Assessments

The post-intervention assessments were conducted in the same manner as the pre intervention assessments.

2.1.6 Experimental Design

This experiment used a combination of a concurrent multiple probe design across participants and pre-posttest design to investigate the effects of establishing conditioned reinforcement for collaboration on learning, collaborative behaviors, and joint attention. The researchers used a concurrent multiple probe design across participants to measure the participants' collaborative behaviors and VVOs. Prior to implementing the intervention, the researchers conducted three pre-intervention collaboration probes for each participant. The first dyad of participants then entered the intervention phase while the other participants remained in baseline. Once the first participant met mastery criterion for the intervention, they underwent post-intervention probes, following each phase of intervention. After the researchers conducted post-intervention collaboration probes for the first participant, the next participant received two more pre-intervention collaboration probes before entering the intervention phase. This design continued for all the participants until they met mastery criterion level in the intervention. Once the participants met criterion in the intervention, the researcher conducted post-intervention collaboration assessments.

The researchers used a pre-posttest design to measure the learn units-to-criterion when learning new operants and joint attention. The researchers conducted the pre-intervention assessment for these measures at the same time as the first pre-intervention assessment for the collaborative behaviors and VVOs during the collaborative activity. Post-intervention assessments were conducted after the participant met mastery criterion for the final phase of intervention.

2.1.7 Interobserver Agreement and Treatment Fidelity

A trained second independent observer collected data to assess interobserver agreement (IOA) within our experiment. For the ELCAR sessions, we calculated trial-by-trial IOA. IOA

was calculated by summing the trials in agreement and dividing by the total number of trials and multiplying by 100%. We collected IOA for 83% of the ELCAR joint attention observing responses assessment sessions with an average of 100% agreement. For the learning task assessment, we calculated trial-by-trial IOA in the same manner. We collected IOA for 36% of the sessions with an average of 100% agreement. For assessing collaborative behaviors, we calculated total count IOA. IOA was calculated by dividing the lower count by the higher count and multiplying by 100%. IOA was collected for 77% of the sessions with an average of 70% agreement (range of 3% to 100%). For assessing VVOs, we calculated total count IOA in the same manner. IOA was collected for 82% of the sessions with an average agreement of 79% (range of 33% to 100%).

An independent observer watched a researcher during the intervention sessions and recorded their accuracy of providing antecedents and consequences for the purpose of collecting treatment fidelity data. Treatment fidelity was collected using a Teacher Performance Rate and Accuracy observation (Ross et al., 2005). Treatment fidelity was calculated by dividing the total number of correct researcher responses by the total number of responses and then multiplying it by 100%. Treatment fidelity was collected for 56% of the instructional opportunities presented during intervention sessions yielding an agreement of 100%.

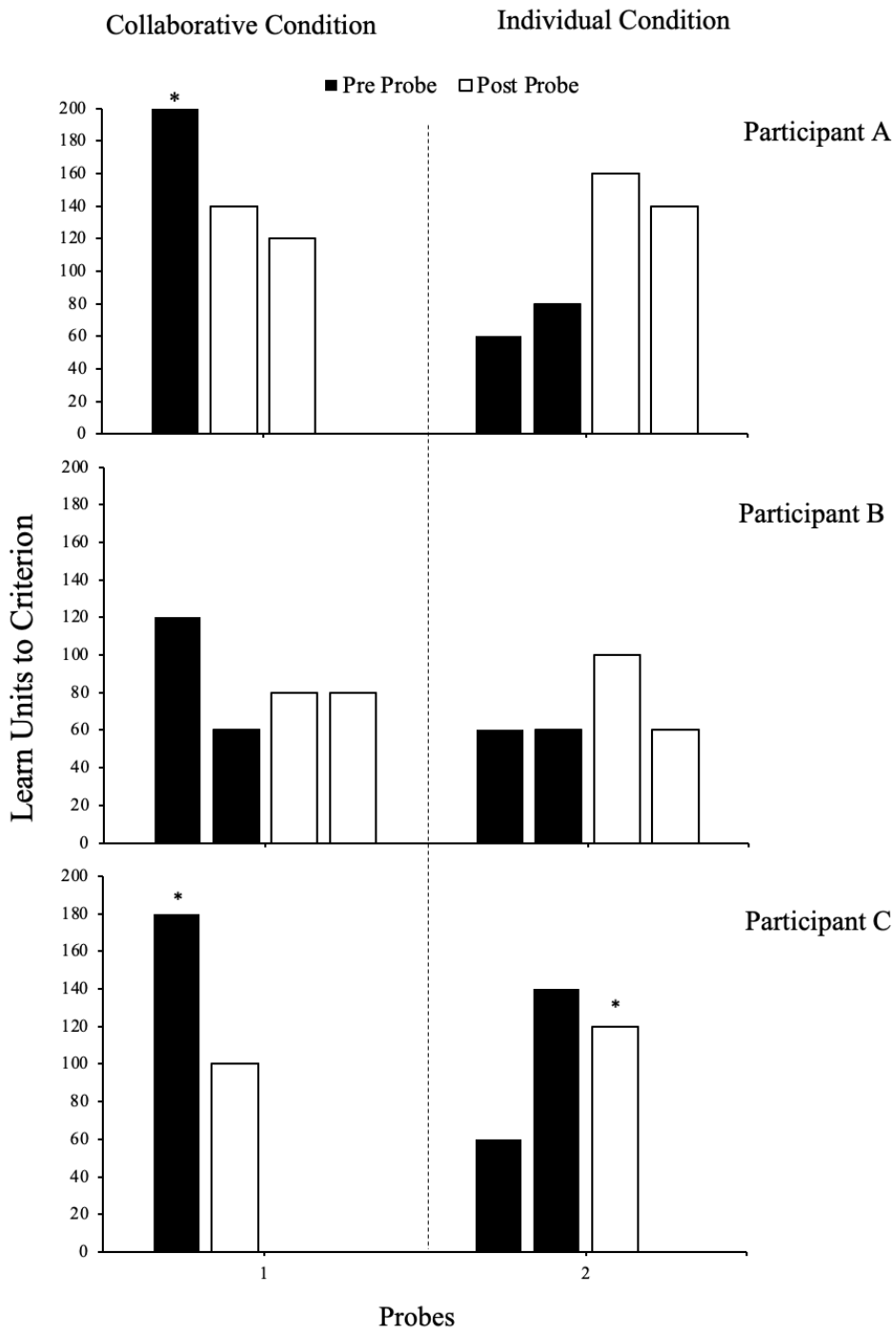
2.2 Results

Figure 2 displays the LUC under both learning conditions (individual and collaborative contingencies. In the pre-intervention assessment, Participant A required 200 LUC in the collaborative contingency and an average of 70 LUC in the individual contingency meaning, demonstrating that the participant learned faster in the individual contingency, compared to the collaborative contingency. In the post-intervention assessments, Participant A required an

average of 130 LUC in the collaborative contingency and 150 LUC in the individual contingency, meaning Participant A learned faster in the collaborative contingency, following intervention. In the pre-intervention assessment, Participant B required an average of 90 LUC in the collaborative contingency and 60 LUC in the individual contingency suggesting that the participant learned faster in the individual contingency. In the post-intervention assessments, Participant B required an average of 80 LUC in the collaborative contingency and 80 LUC in the individual contingency, suggesting that the participant learned at the same rate in both conditions. In the pre-intervention assessment, Participant C required 180 LUC in the collaborative contingency and an average of 100 LUC in the individual contingency, meaning the participant learned faster in the individual contingency. Following intervention, Participant C required 100 LUC in the collaborative contingency and 120 LUC in the individual contingency. Due to school ending, the participant was not able to finish the assessment to meet criterion. Overall, Participants A and C demonstrated faster learning in the collaborative contingency, following intervention, meaning they required fewer learn units to meet mastery criterion. Participant B required the same number of learn units to meet mastery criterion in both conditions.

Figure 2

Learn Units to Criterion

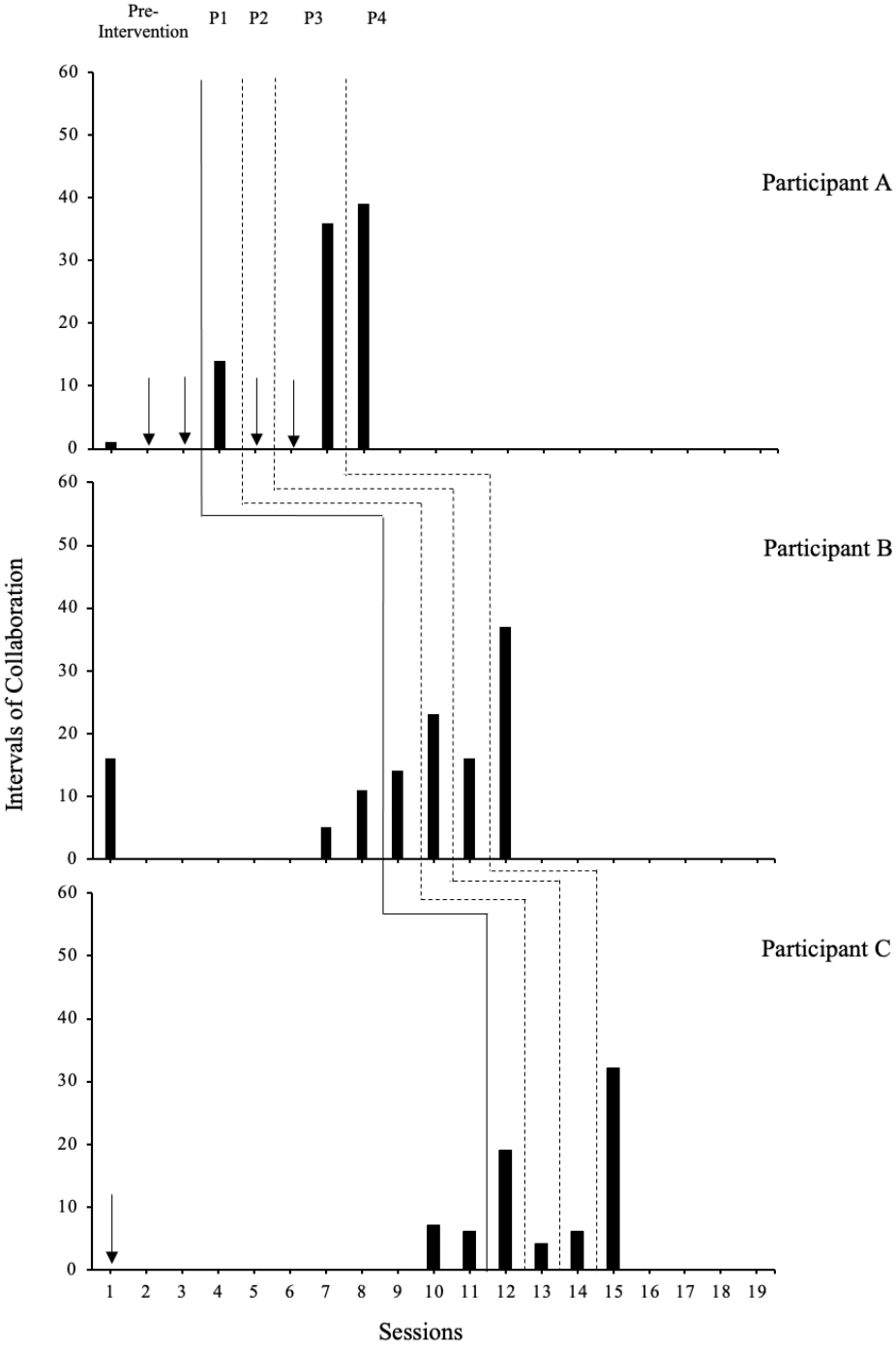


Note * The participant did not meet the mastery criterion during the assessment

Figure 3 displays the number of instances of collaborative behaviors during the collaborative activity. Across three pre-intervention assessments, Participant A demonstrated an average of 0.33 collaborative behaviors. During the last post-intervention assessment, Participant A demonstrated 39 instances of collaborative behaviors. Across three pre-intervention assessments, Participant B demonstrated an average of 10.6 instances of collaborative behaviors. During the last intervention assessment, Participant B demonstrated 37 instances of collaborative behaviors. Across three pre-intervention assessments, Participant C demonstrated an average of 4.3 instances of collaborative behaviors. During the last intervention assessment, Participant C demonstrated 32 instances of collaborative behaviors. Overall, all three participants demonstrated increases in their collaborative behaviors from pre-intervention to the final assessment during the collaborative activity.

Figure 3

Collaborative Behavior Assessment

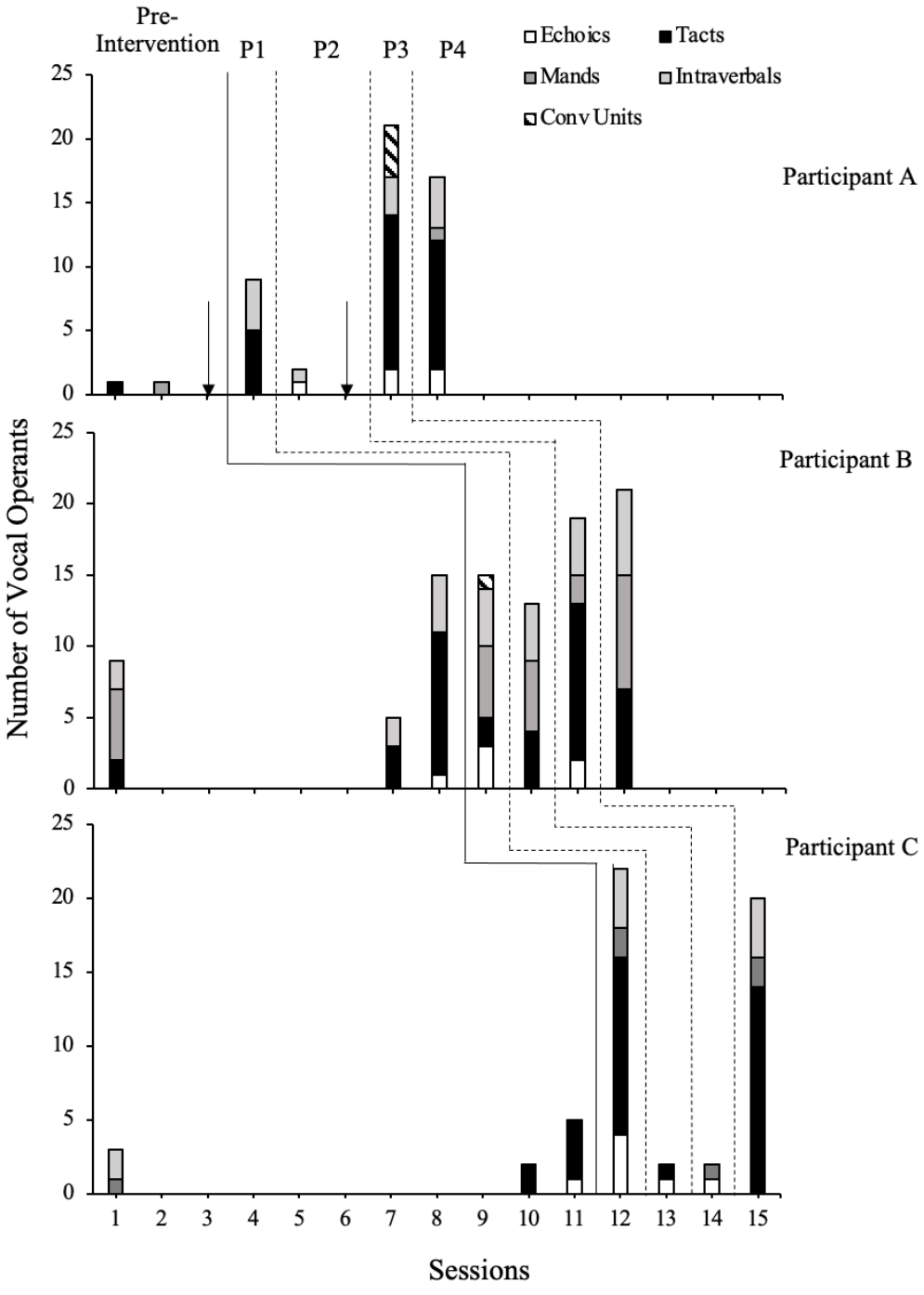


*Note** The maximum number of intervals is 60. P1, P2, P3, and P4 refer to post-intervention assessments following each phase of intervention.

Figure 4 displays the number of vocal operants emitted towards peers during the collaborative activity. Across three pre-intervention assessments, Participant A emitted an average of 0 echoics, 0.33 tacts, 0.33 mands, 0 intraverbals, and 0 conversational units. Following phase 1 of intervention, Participant A emitted more tacts and intraverbals, compared to pre-intervention assessments. Participant emitted the most VVOs towards a peer following the third phase of intervention. Across three pre-intervention assessments Participant B emitted an average of 0.33 echoics, 5 tacts, 1.66 mands, 2 intraverbals, and 0 conversational units. Following each phase of intervention, Participant B demonstrated an increase in VVOs emitted towards a peer with the most operants emitted after the final phase. Across three pre-intervention assessments, Participant C emitted an average of .33 echoics, 2 tacts, 0.33 mands, 0.67 intraverbals, and 0 conversational units during pre-intervention assessments. During the last post-intervention assessment, Participant C only demonstrated increases in VVOs towards a peer following the first and last phase of intervention. Overall, all participants demonstrated increases in their emission of VVOs towards a peer following the intervention. More specifically, all participants emitted more intraverbals, following intervention. The participants emitted an average of 0, 2, and .67 intraverbals during pre-intervention assessments. Following intervention, the participants emitted an average of 4, 6, and 4 intraverbals, respectively.

Figure 4

Vocal Operants to Peers During Collaboration Activity



*Note** P1, P2, P3, and P4 refer to post-intervention assessments following each phase of intervention.

Figures 5 and 6 display the joint attention scores on the C-JARS. Figure 5 displays both the prosocial and asocial average item scores pre and post intervention. According to the parent, Participant A increased by 0.34 in prosocial behaviors and a .08 increase in asocial behaviors. According to the teacher, Participant A increased by 1.41 in prosocial behaviors and decreased asocial behaviors by 1.07. According to the parent, Participant B increased prosocial behaviors by .7 and decreased asocial behaviors by .07. According to the teacher, Participant B increased by 1.42 in prosocial behaviors and decreased by 1.14 in asocial behaviors. According to the parent report, Participant C demonstrated a .09 decrease in prosocial behaviors and a .36 decrease in asocial behaviors. According to the teacher, Participant C increased by 1.08 in prosocial behaviors and decreased by 1.22 in asocial behaviors. Overall, participants A and B demonstrated increases in prosocial behaviors, according to both parent and teacher reports. However, Participant C demonstrated a small decrease in prosocial behaviors. The classroom teacher reported decreases in asocial behaviors for all three participants. The parents' reports for Participants B and C also demonstrated decreases in asocial behaviors. However, a parent of Participant A reported a slight increase in asocial behaviors.

Figure 5

C-JARS Prosocial and Asocial Average Item Scores by Time and Respondent

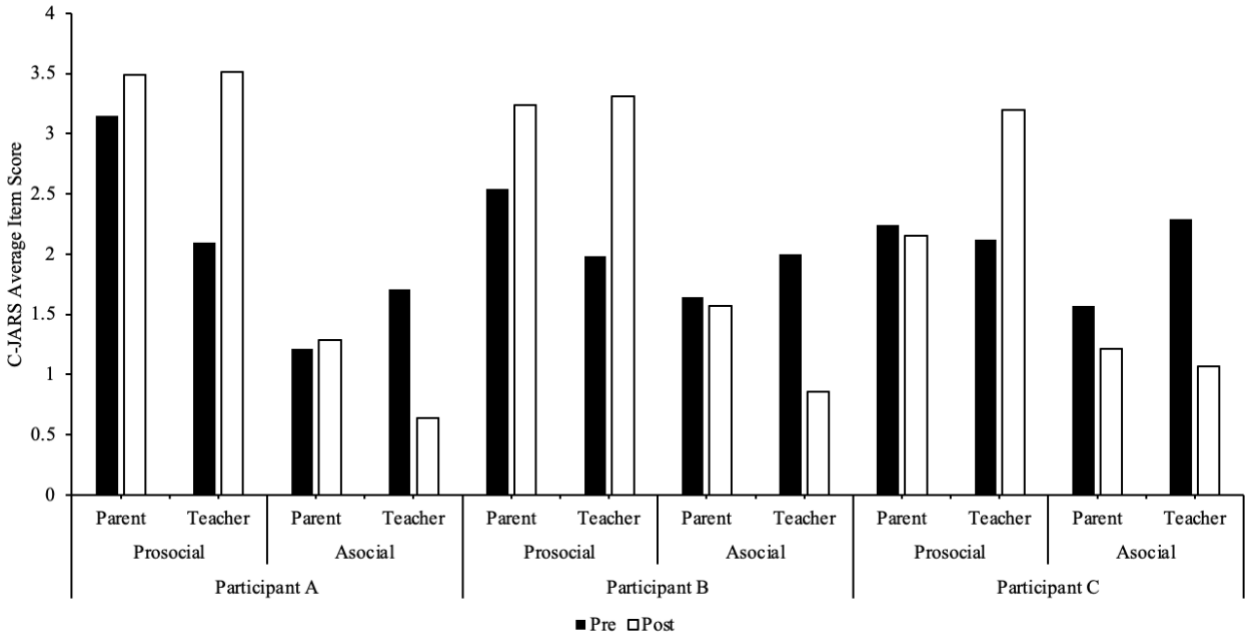


Figure 6 displays the C-JARS summary scores. The summary scores were calculated by subtracting the average score across asocial items from the average score of prosocial items. The higher items reflect parent and teacher report evidence of a pattern of behaviors characteristic of typical joint attention development. Lower scores reflect parent and teacher evidence of a pattern of behaviors characteristic of atypical joint attention development or increased infrequent joint attention behaviors. A score of 4 represents the highest prosocial score while a score of -4 represents the highest asocial score. Participant A demonstrated an increase from 1.93 to 2.2 according to the parent report and an increase from 0.38 to 2.87 according to the teacher report. Participant B demonstrated an increase from 0.89 to 1.67 according to the parent report and an increase from -0.02 to 2.46 according to the teacher report. Participant C demonstrated an increase from .69 to .93 according to the parent and an increase from -0.16 to 2.12 according to the teacher report. All three participants demonstrated an increase in behaviors characteristic of typical joint attention, following intervention.

Figure 6

C-JARS Summary Scores by Time and Respondent

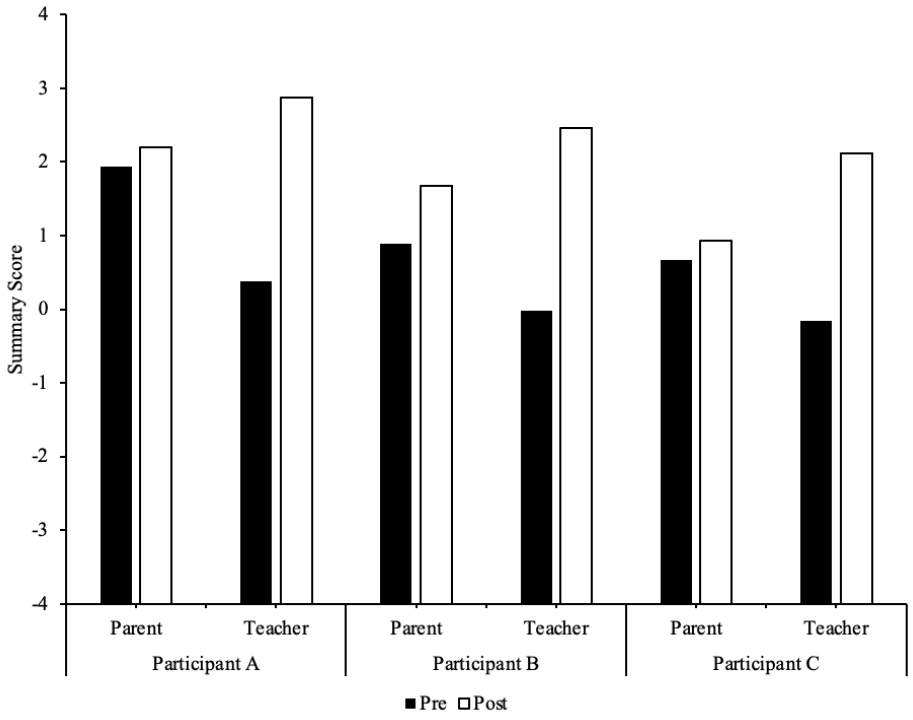


Table 7 displays the joint attention observing responses towards peers scores on the ELCAR. During this assessment, the maximum number of correct observing responses was 4. During pre-intervention assessments, Participant A emitted an average of .66 correct responses across 3 assessments of joint attention observing responses towards peers. During post-intervention assessments, Participant A emitted an average of 2.33 correct observing responses across 3 assessments. During the pre-intervention assessments, Participant B emitted an average of 0 correct observing responses across 3 assessments. During the post-intervention assessments, Participant B emitted an average of 2.67 correct observing responses across 3 assessments. During pre-intervention assessments, Participant C emitted an average of 1 correct observing responses across 3 assessments. During post-intervention assessments, Participant C emitted an average of 3 correct observing responses across 3 assessments. According to the ELCAR, all three participants demonstrated increases in their joint attention observing responses towards peers, following intervention. Overall, all participants demonstrated an increase in joint attention observing responses towards peers, following intervention.

Table 7

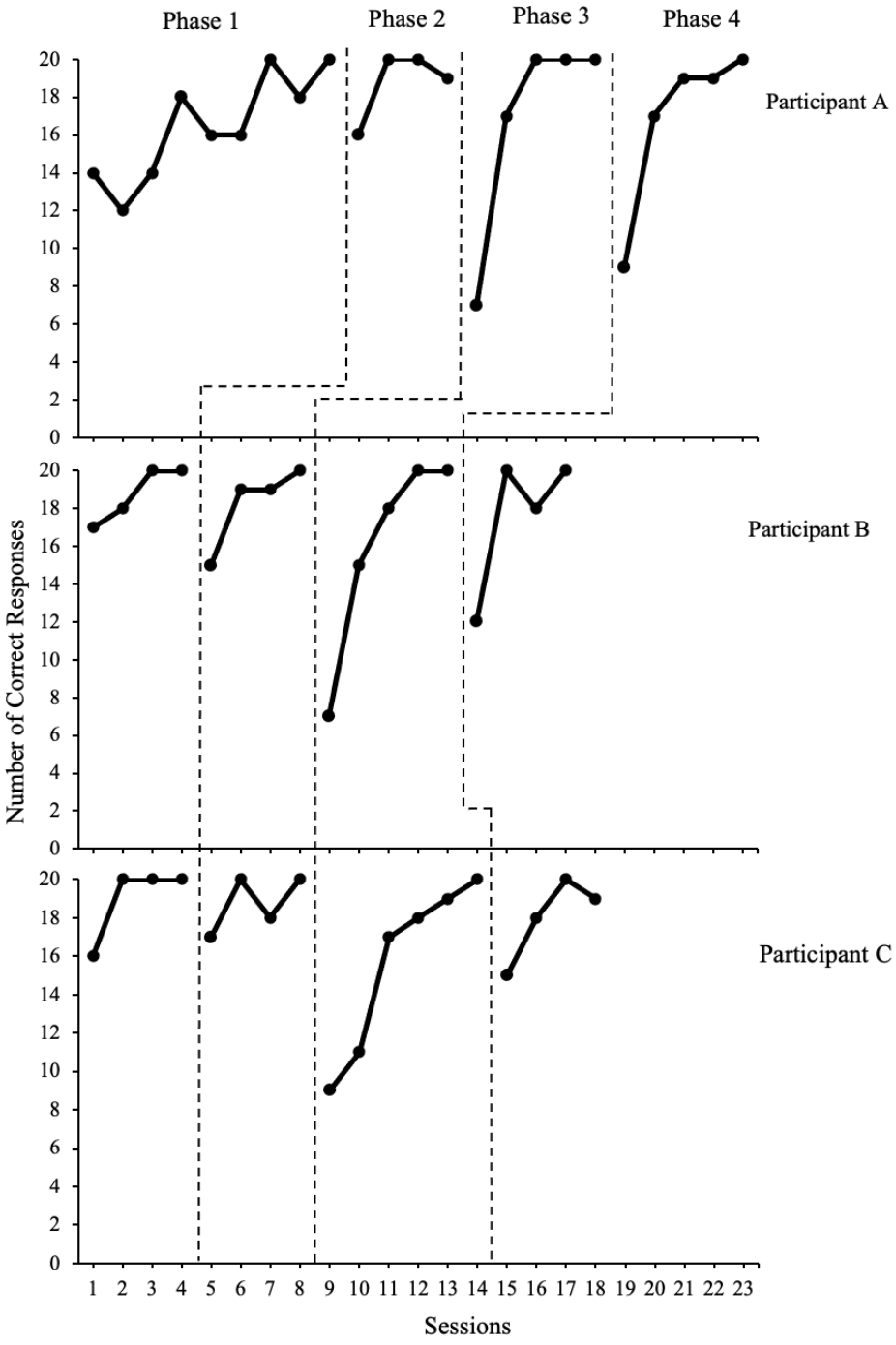
ELCAR Joint Attention Observing Responses to Peers Assessment

	Pre-Intervention	Post-Intervention
Participant A	0, 1, 1	3, 1, 3
Participant B	0, 0, 0	3, 3, 2
Participant C	1, 1, 1	3, 3, 3

Figure 7 displays the intervention graph for all participants. Participant A met criterion in phases 1, 2, 3, and 4 in 9, 4, 5, and 5 sessions, respectively. Participant B met criterion for phases 1, 2, 3, and 4 in 4, 4, 5, and 4 sessions, respectively. Participant C met criterion for phases 1, 2, 3, and 4, in 4, 4, 6, and 4 sessions, respectively. On average, the participants required about 4.8 sessions of each phase of intervention to meet mastery criterion of 90% accuracy across three consecutive sessions.

Figure 7

Intervention Graph



2.3 Discussion

Collaborative activities have been theorized as a general education technique that was described as critical (Cook & Friend, 1991) and used to promote effective teaching (Laal & Laal, 2012). Research has also supported a "9-month revolution" in which 9-month-old children develop a "we" intentionality and begin to participate in activities with another person (Tomasello et al, 2005). However, there has been a lack of empirical research on the importance of establishing reinforcement for collaboration in young students with disabilities. This study demonstrated that reinforcement for collaboration could be established in young children with disabilities as evidenced through increases in collaborative behaviors during a collaborative activity, emission of VVOs during the same activity, speed of learning under a collaborative contingency, and joint attention observing responses toward peers. The SLR intervention provided the participants with multiple collaborative activities to access collaborative reinforcement.

In this study, all three participants demonstrated an increase in the number of instances of collaboration with a peer from the first assessment to the final assessment when told to complete a floor puzzle. That is, after contacting and mastering multiple different collaborative activities, participants demonstrated the generality of this newfound repertoire on a novel task that was never directly targeted during intervention. Similarly, all three participants demonstrated increases in their vocal verbal operants emitted towards a peer while completing the floor puzzle. According to both the ELCAR joint attention observing responses and the C-JARS joint attention assessments, all three participants showed increases in their joint attention observing responses toward peers. The learning measure demonstrated variable results as there was only an apparent difference in learning conditions for Participants A and C. To support that

reinforcement for collaboration is a verbal behavior developmental cusp, all the participants should have learned faster in the collaborative contingency compared to the individual contingency, following intervention. Overall, the intervention taught the children to communicate more, as evident by the increase in emission of vocal verbal operants towards peers. The children started looking at each other's actions, as evident by their increases in joint attention towards peers. Additionally, the children learned to take turns and work together towards shared goal, as evident by increases in collaborative behaviors during a novel task (floor puzzle).

Although there were positive results for the participants' collaborative behaviors, there are a few limitations in this study. First, the researchers found increases in the speed of learning in the collaborative contingency for two of the three participants. Participant B demonstrated the same average speed of learning across both conditions in the post-intervention assessment. Further, due to the amount of instructional time and effort required to conduct these assessments, Participants A and C only completed one pre-intervention assessment in the collaborative condition and Participant C did not meet criterion in the post-intervention assessment in the individual contingency condition. To fully contribute to evidence of collaboration as a verbal behavior developmental cusp, future researchers should adapt this learning measure to demonstrate more significant changes in speed of learning in group instruction.

Secondly, the researchers conducted IOA for the collaborative behaviors using total-count IOA. By using this method of collection, the researchers could not guarantee their observations occurred within the same 5 s interval. Because of this, when one observer counted three instances of collaboration and the other observer counted one instance, the calculated agreement for that assessment was only 33%. Future studies will improve the collaboration

coding training by effectively training the second observers while collecting more precise IOA. To collect more accurate agreement, future studies should use trial-by-trial IOA to calculate the number of intervals the observers agreed upon.

It is important to acknowledge that the participants collaborative behaviors and VVOs were only recorded for 5 min during the floor puzzle. There is a possibility that if the sample was a longer duration, the researchers may have seen more collaborative behaviors and VVOs emitted. Similarly, the researchers only used a floor puzzle to measure the participants' instances of collaboration and vocal behavior. However, the classroom staff anecdotally observed collaborative behaviors throughout the day and across various activities. Future research should consider expanding the 5 min time sample and the activities selected for the participants to include their preferred items of interest. Along with considering the participants' preferred interests, the researchers observed more instances of collaboration with alphabet puzzles, compared to other puzzles used throughout the collaborative behavior assessment. The alphabet puzzle contained a definitive start and end that may have led to the completion of the puzzle. Therefore, future research should ensure all puzzles have some sort of clear start and end, like the alphabet, or none at all. Additionally, the type of puzzle given to the students may have affected their desire to complete it. For example, a student may have wanted to do a dinosaur puzzle more than a garden puzzle, and vice versa. Instead of the researcher giving the students a pre-selected puzzle, future researchers could give the students a variety to choose from.

Based on teacher observations, there was a general increase in the participants' VVOs towards peers, sharing skills, cooperative play skills, and overall social skills. Due to these anecdotal observations, future studies should attempt to target more generalized incidents of collaboration with peers. To do this, researchers could incorporate more observations throughout

the day in non-instructional settings with various activities to partake in collaborative behaviors or consider student preferences towards various activities. It is also noteworthy to consider the learning conditions and ways to improve upon the structure and efficiency of the assessment. Specifically, the assessments took a significant amount of instructional time and could be revised to be conducted in a more efficient and timely manner. Although there were increases in the joint attention measures in this study, future research could consider stronger ways to capture overall peer interactions and joint engagement through collaborative behaviors.

This study demonstrated that educators could establish and improve collaborative behaviors in young children with disabilities and promote their social skills towards peers. There were increases in the participants' collaborative behaviors during a floor puzzle observation, an increase in VVOs with peers, and some effects on learning in a collaborative contingency compared to individual contingency. Both the participants' parents and teacher also reported increases in their prosocial behaviors on the C-JARS assessment. Through anecdotal observation, it was noted that the participants demonstrated positive social changes in their daily interactions with peers, service providers, and teachers. Future research should examine ways to improve the efficiency of the procedure and better capture participants' collaborative behaviors and social behaviors with peers.

2.3.1 Rational for Experiment 2

Experiment 2 addressed limitations of Experiment 1 by shortening the intervention to maximize instructional time and by altering the learning measure to more efficiently capture changes in learning when working in a group. In Experiment 2's intervention, there were 3 phases of intervention, instead of 4. Phase 2, "20 questions" was removed from the sequence of phases in Experiment 2 to remove redundancy. However, the remaining of the sequence was

designed to teach the participants the necessary prerequisites for each phase of intervention and build up the verbal components to respond correctly and contact reinforcement in the final phase of intervention.

Additionally, Experiment 2 broadened the changes in social measures to capture joint engagement with peers, rather than solely, joint attention. To measure general social skill changes, the researcher used a different standardized measure, the Social Skills Improvement System (SSIS) rather than the C-JARS assessment. Experiment 2 also considered the preschool participants' preferences of doing activities alone, compared to with a peer. Instead of directly replicating the intervention to include all original 4 phases, Experiment 2 included 3 phases, with the removal of the "20 questions" phase. Also, the learning criteria were shortened from at least 90% accuracy across 3 sessions to at least 90% accuracy across 2 sessions. Additionally, Experiment 2 aimed to improve data collection, procedural training, and IOA.

Experiment 2 will answer the following questions:

1. Will the establishment of reinforcement for collaboration have effects on the participants' LUC during dyad instruction?
2. Will the establishment of reinforcement for collaboration have effects on the participants' collaborative behaviors, joint engagement behaviors, and vocal verbal operants emitted towards a peer during a collaborative activity?
3. Will the establishment of reinforcement for collaboration have effects on the participants' social skills, according to the participants' parent and teacher?
4. Will the establishment of reinforcement for collaboration have effects on the participants' preference to complete an activity with a peer versus alone?

Chapter 3: Experiment 2

3.1 Method

3.1.1 Participants

Three preschool students, who were not a part of Experiment 1, participated in this study. All participants attended a Comprehensive Application of Behavior Analysis to Schooling model preschool 5 days a week for 5 hr per day. Participants D and G were in an integrated preschool classroom, while Participant F started in a self-contained special education classroom and moved to an integrated classroom during this experiment. Integrated classrooms consist of students' both with and without disabilities, while self-contained classrooms consist of students only with an IEP (Individualized Education Program). Students in integrated classrooms typically demonstrate high levels of self-management and vocal verbal behavior. Students in self-contained classrooms typically require more prompting, support, and individualized instruction. Along with the three participants, three peers also participated, who already demonstrated collaboration as a reinforcer. See Table 8 for participants' and peers' descriptions and demographics. The researchers selected participants for the study due to their few observed instances of collaborative behaviors in the collaborative activity assessment and selection to complete activities alone. The researchers included an exclusion criterion where, if a participant selected to complete an activity with a peer over 50% of the opportunities presented during the preference assessment, the participant would be excluded from the study. Therefore, for a participant to be included, they were required to select to engage with a peer less than 50% of the time or choose to complete an activity alone more than 50% of the sessions. Peers were selected to participate in this study because they demonstrated appropriate vocal verbal behavior towards teachers and

adults, demonstrated positive social skills and appropriately engaged with other classmates regularly.

Table 8

Participant Demographical Information for Experiment 2

	Participant D	Participant F	Participant G	Peer D	Peer F	Peer G
Age	5.0	4.6	4.10	4.10	5.1	4.7
Gender	Male	Female	Male	Male	Female	Male
Disability	Preschooler with a disability	Preschooler with a disability	Preschooler with a disability	Preschooler with a disability	Preschooler with a disability	Preschooler with a disability
Race	White	Black	Black	White	Black	White
VBDT Cusps and Capabilities	Conditioned reinforcement for 2D stimuli, voices and faces, mands, tacts, Inc-UniN for familiar stimuli	Conditioned reinforcement for 2D stimuli, voices and faces, mands, tacts, Inc-UniN for familiar stimuli	Conditioned reinforcement for 2D stimuli, voices and faces, mands, tacts, Inc-BiN for familiar stimuli	Conditioned reinforcement for 2D stimuli, voices and faces, mands, tacts, Inc-BiN for familiar stimuli, observational learning	Conditioned reinforcement for 2D stimuli, voices and faces, mands, tacts, Inc-BiN for familiar stimuli, observational performance	Conditioned reinforcement for 2D stimuli, voices and faces, mands, tacts, Inc-BiN for familiar stimuli, observational learning

3.1.2 Setting and Materials

The study took place in the researcher's integrated preschool classroom, in the same school in Experiment 1. Each intervention session took place at a student desk. The researcher sat next to the participant and peer for all intervention sessions. The collaborative activity assessments took place in a hallway outside of the researcher's classroom and required the floor puzzle and iPad for filming. For the LUC assessments, the researcher used two sets of novel visual stimuli presented on Google Slides. See Table 9 for learning stimuli used in Experiment 2. Each set of stimuli consisted of five different pictures with four exemplars per picture. The researcher counterbalanced the learning sets of stimuli across participants and ensured there were the same number of syllables in each name of the stimuli across sets. See Table 10 for the order in which each participant learned each set of tact stimuli.

Table 9

Stimuli Used in Learn Unit to Criterion Assessment in Experiment 2

Set A	Set B	Set C	Set D
Crockpot	Frenchpress	Puffin	Geyser
Fryer	Sifter	Caribou	Plateau
Yacht	Mixer	Laptop	Condor
ATV	Crane	Blackberry	Heron
Jetski	Moped	Lemming	Parakeet

Table 10

Order of Sets of Stimuli Taught During the Learning Measure

Assessments	Participant D	Participant F	Participant G
Pre-Assessment 1	Set A	Set C	Set D
Pre-Assessment 2	Set B	Set A	Set C
Post-Assessment 1	Set D	Set B	Set A
Post-Assessment 2	Set C	Set D	Set B

3.1.3 Dependent Variables and Measurement

There were five dependent variables in this study: collaborative and joint engagement behaviors and vocal verbal operants during a collaborative activity, preference for an activity alone or with a peer, LUC during instruction, and a social skills assessment, called the Social Skills Improvement System (SSIS).

Collaborative and Joint Engagement Behaviors During Collaborative Activity. Collaborative and joint engagement behaviors were measured using 5 s partial interval recording throughout a 5 m video recording of the participants in the collaborative activity. In this experiment, collaborative and joint engagement behaviors consisted of the same definition as in Experiment 1: passing a puzzle piece to the peer, accepting a piece from the peer, requesting a piece, requesting help from the peer, placing the puzzle pieces together. However, in Experiment 2, there was the addition of any instance of the participant observing the peer actively engaged with the puzzle within a foot from the peer that constituted joint engagement. See Table 11 for examples and non-examples of behaviors measured during the floor puzzle.

Table 11

Collaborative and Joint Engagement Behavior Examples and Nonexamples

Behavior	Examples	Nonexamples
Pass puzzle piece	Child A holds puzzle piece, turns to child B and places piece in child B's hand.	Child A places puzzle piece themselves or does not physically touch a piece.
Accept puzzle piece	Child A takes puzzle piece from child B's hand.	Child A does not physically take piece from child B or ignores Child B.
Request a piece	Child A vocally says to child B, "Can I have that?" or "put it here" for example.	Child A vocally says something to themselves or the researcher recording.
Request help from peer	Child A vocally says to child B,"Help" or "Where does this go?" for example.	Child A vocally says something to themselves or the researcher recording.
Places piece together with peer	Child A and child B both have their hands on the same puzzle pieces and attach them together.	Child A places two pieces together independently of Child B placing pieces together.
Observing peer actively engaged with puzzle within one ft	Child A (within 1 ft of Child B), looks at them placing puzzle pieces together or looking for a puzzle piece.	Child A does not look towards Child B placing puzzle pieces or looks at the wall or ceiling.

Vocal Verbal Operants Emitted During Collaborative Activity. The VVOs measured during the collaborative activity included: echoics, mands, tacts, intraverbals, and conversational units to peers. This was the same measurement used in Experiment 1.

Preference for Activity Alone or With a Peer. The researchers measured the participants' cumulative choices for their preference of working together with a peer or alone. Prior to intervention, the researchers asked the participant if they would like to color, read a book, and play on the playground either alone or with a peer across 3 consecutive days, for a total of 9 opportunities pre-intervention. Following intervention, the researchers provided the participants with the same 3 options for activities across 3 more days, for a total of 9 more opportunities post-intervention. The researcher recorded whether the participant chose to complete the activity alone or with a peer by indicating "A" for alone and "P" for with a peer for each activity.

Learn Units to Criterion. The researchers measured the participants' learning by LUC during dyad instruction when learning the names of various stimuli. Prior to intervention, the researcher taught the children in the dyad two sets of instructional stimuli. Following intervention, the researcher taught two novel sets of stimuli to the same dyad. See Table 9 for stimuli used in each instructional objective. A correct response was recorded if the participant and peer vocally stated the correct name of the stimulus in unison after the researcher delivered the signal. An incorrect response was recorded if the participant and peer did not say the correct name of the stimulus, did not respond in unison, or did not respond at all within 5 s.

SSIS. The Social Skills Improvement System (SSIS) included both a parent and teacher assessment form. The researcher gave the parent and teacher their individual assessment forms prior to and following intervention. The parent form consisted of 79 items, 46 social skills items,

and 33 problem behavior items. The teacher form consisted of 76 items, 46 social skills items, and 30 items for problem behavior items. Social behaviors included communication, cooperation, assertion, responsibility, empathy, engagement and self-control. Items that were reported under communication domain included, “says please” and “ uses appropriate language when upset.” Cooperation items included, “follows your directions” and “participates appropriately in class.” Examples of assertion items were: “asks for help from adults” and “ stands up for himself when treated unfairly.” Examples of responsibility items were: “acts responsibility when with others” and “respects the property of others.” Items reported under empathy included, “tries to comfort others” and “feels bad when others are sad.” Engagement items included, “joins activities that have been started” or “participates in group games or activities.” Lastly, examples of self-control items include, “stays calm when teased” and “ takes criticism without getting upset.” Behaviors were rated as occurring never, seldom, often, or almost always. Social skills were also rated by importance for success, as not important, important, or critical. Once the researcher received completed teacher and parent forms, the researcher used the SSIS scoring instructions to calculate the raw data on the social skills items (Gresham & Elliot, 2008).

3.1.4 Procedure

Pre-Intervention Assessments

Learn Units to Criterion. Different from Experiment 1, the researcher assessed the efficiency of acquiring novel tact responses in a dyad. During each session, two children worked with a researcher. The researcher presented learn units to both children at the same time. The researcher presented the children with an iPad or computer screen that displayed the stimulus (picture). The children were required to chorally respond in unison for each trial to receive

reinforcement. When the participant or peer emitted a correct response, the researcher delivered vocal praise to the specific child, or both if both responded correctly. If one child emitted an incorrect response or did not respond in unison with their peer, the researcher delivered an error-correction procedure to that individual. For the error-correction procedure, the researcher said, "What is it?" and then said the correct name of the picture. The researcher then asked the participant again, "What is it?" and provided the participant an opportunity to independently emit the tact response. After the error-correction procedure, the researcher did not deliver any praise and moved on to the next stimulus. Once the participants completed their 20 learn units of instruction, the researcher delivered a reinforcer to the children for completing their work.

Preference for Activity Alone or With a Peer. Prior to the classroom reading time, the researcher asked the participant, "Do you want to read a book alone or with a friend?" If the participant selected to read alone, the researcher had the participant pick a book and sit alone to read. If the participant selected to read with a friend, the researcher had the participant sit on the class library couch with peers and look at books. The researcher then recorded if the participant selected to read alone or with a peer. The same procedure continued for class coloring time and when told to pick a table-top activity during free-play. The researcher presented the participants these opportunities (coloring, reading, and free-play activity) daily across 3 school days.

Collaborative Activity with an Embedded Verbal Operant Assessment. Prior to the collaborative activity, the researcher gave the participant and peer an option of two puzzles to select from. Once one puzzle was selected, another replaced it as an option for the future assessment to limit the repetition of the same puzzle throughout the collaborative activity assessments. Prior to conducting the floor puzzle assessment, the researcher taught both the participant and peer, individually, how to interlock a jigsaw puzzle. During this time, the

researcher sat with one child and modeled how to complete the puzzle. For example, the researcher prompted the child to look at the picture on the puzzle box and find pieces that are near each other. When the child put correct pieces together, the researcher would deliver praise, such as, “Yes, that piece goes there!” or “Great, now find the next piece that completes it.” If the child did not find the correct piece, the researcher would vocally prompt the child or give them the correct piece to interlock. The researcher continued to teach the child how to complete the puzzle until the entire puzzle was completed. The researcher exposed all children in the study to two novel puzzles before conducting the collaborative activity. When it came time to conduct the collaborative activity assessment and the students decided on a puzzle, the researcher told the participant and peer to come into the hallway and said, “You friends are going to do a floor puzzle together!” The collaborative activity and vocal verbal operants assessment was conducted in the same manner as in Experiment 1, with the addition of the change in definition of collaborative behaviors, as explained above.

Social Skills. During the SSIS assessment, the researcher gave the classroom teacher and parents the printed scale to fill out independently, prior to the start of intervention and again at the end of intervention. Once the researcher received both forms, the researcher scored the participants’ raw scores and determined behavioral levels based off the SSIS scoring instructions.

Intervention

During all phases of intervention, the participant and the peer sat next to each other and in front of the researcher. The researcher first asked the children what they wanted to earn if they made it to the top of the game board and assisted in choosing a shared item, game, or activity. Through all phases of intervention, if the participant emitted the correct response, the researcher

delivered vocal praise to both children and respectively moved up their game board piece on the board. If the participant emitted an incorrect response or did not respond at all within 5 s, the researcher delivered an error-correction procedure and respectively moved the researcher's game board piece up the board. The procedure continued for the 20 learn units. During all phases of intervention, if the children's game board piece reached the top of the game board, or met mastery criteria of at least 90% accuracy, the researcher reinforced their behavior with their pre-selected, shared reinforcer. If the researcher reached the top of the game board before the children, or they did not reach criterion level, the children did not receive their pre-selected reinforcer. The researcher then said, "You can try again tomorrow!" The Experiment 2 intervention was the same as the first experiment's intervention, with the removal of the second phase, "20 Questions." The researcher removed the phase as it appeared redundant from the first phase and potentially unnecessary to see positive effects on collaboration. Additionally, the mastery criterion to proceed to the next phase of intervention changed to 90% accuracy across two consecutive sessions. I-Spy, peer tutoring, and block tower construction task were all conducted in the same manner as Experiment 1.

Post-Intervention Assessments

The post-intervention assessments were conducted in the same manner as the pre intervention assessments.

3.1.5 Experimental Design

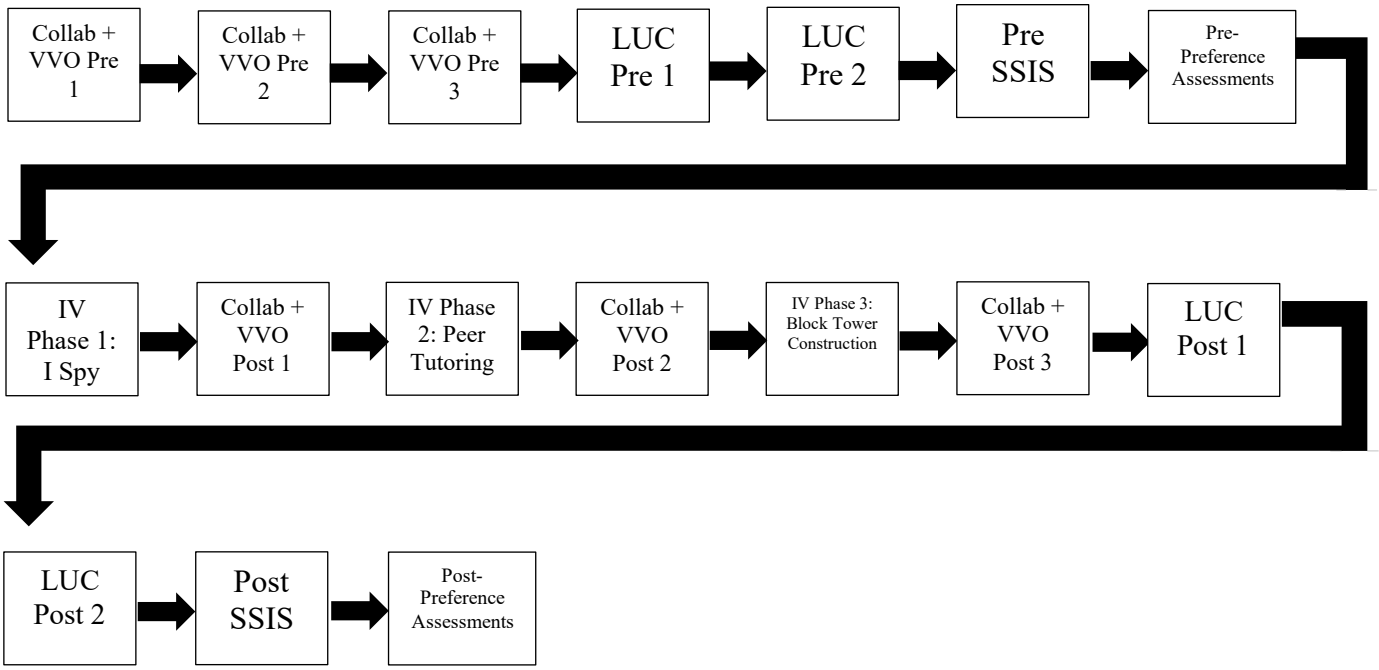
The researchers implemented a combination of a delayed multiple probe design across participants and pre-posttest design to investigate the effects of establishing conditioned reinforcement for collaboration on learning, collaborative behaviors, vocal verbal behavior, and social skills. The researchers used a delayed multiple probe design across participants to measure

the participants' collaborative behaviors and VVOs. The first two participants were conducted in a traditional concurrent multiple probe design, however, the third participant did not receive his first pre-intervention assessment until after the second participant had begun intervention. Once the participants met criterion in the intervention, the researcher conducted post-intervention collaboration assessments.

The researchers used a pre-posttest design to measure the participants' LUC during dyad instruction, preference to do an activity alone or with a peer, and social skills. The researchers conducted the pre-intervention assessment for these measures at the same time as the first pre-intervention assessment for the collaborative behaviors and VVOs during the floor puzzle. Post-intervention assessments were conducted after the participant met mastery criterion for the final phase of intervention. See Figure 8 for the sequence of the procedure.

Figure 8

Sequence of Procedure



3.1.6 Interobserver Agreement and Treatment Fidelity

A trained second independent observer collected data to assess interobserver agreement (IOA) within our experiment. For most dependent variables and the intervention, we calculated trial-by-trial IOA. Trial-by-trial IOA was calculated by summing the trials in agreement and dividing by the total number of trials and multiplying by 100%. We collected IOA for 82% of the intervention sessions with an average agreement of 99% (range of 90% to 100%). We collected IOA for 61% of learning task sessions with an average of 99% agreement (range of 90% to 100%). For assessing collaborative behaviors, IOA was collected for 90% of the sessions with an average of 92% agreement (range of 80% to 98%). For assessing preference to complete an activity alone versus with a peer, we collected IOA for 85% of the opportunities with an average agreement of 100%. For assessing VVOs, we calculated total count IOA. Total count IOA was calculated by dividing the lower count by the higher count and multiplying by 100%. IOA was collected for 90% of the sessions with an average agreement of 87.5% (range of 74% to 100%).

An independent observer watched a researcher during the intervention sessions and recorded their accuracy of providing antecedents and consequences for the purpose of collecting treatment fidelity data. Treatment fidelity was collected using a Teacher Performance Rate and Accuracy observation (Ross et al., 2005). Treatment fidelity was calculated by dividing the total number of correct researcher responses by the total number of responses and then multiplying it by 100%. Treatment fidelity was collected for 56% of the instructional opportunities presented during intervention sessions yielding an agreement of 100%.

3.2 Results

Figure 9 displays the LUC during dyad instruction for two sets of tact stimuli both, pre- and post-intervention. In the pre-intervention assessments, Participant D required on average,

140 LUC to meet the mastery criteria, and following intervention, Participant D required on average, 100 LUC to meet the mastery criteria, meaning, the participant learned to tact stimuli faster in a dyad instruction setting, following intervention. In the pre-intervention assessments, Participant F required on average, 180 LUC to meet the mastery criteria, and following intervention, Participant F required on average, 130 LUC to meet the mastery criteria. In the pre-intervention assessments, Participant G required on average, 230 LUC to meet the mastery criteria, and following intervention, Participant G required on average, 140 LUC to meet the mastery criteria, meaning, the participant learned to tact stimuli faster in a dyad instruction setting following intervention.

Figure 9

Learn Units to Criterion During Dyad Instruction

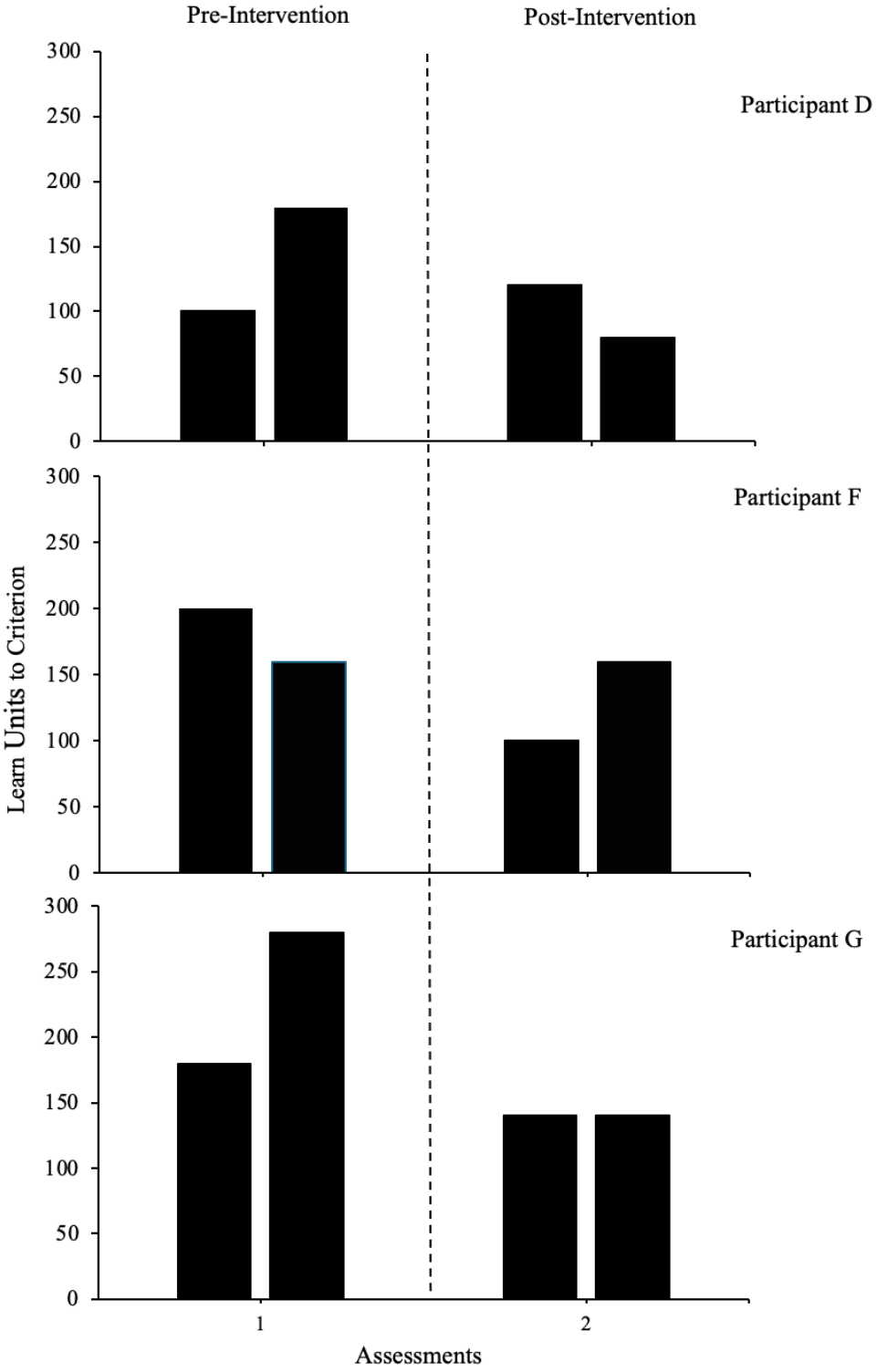


Figure 10 displays the instances of collaborative and joint engagement behaviors during a collaborative activity with a peer. Across three pre-intervention assessments, Participant D emitted an average of 24.7 instances of collaborative and joint engagement behaviors. During the final assessment, Participant D emitted 39 instances of collaborative and joint engagement behaviors. Across four pre-intervention assessments, Participant F emitted an average of 15.3 instances of collaborative and joint engagement behaviors. During the final assessment, Participant F emitted 54 instances of collaborative and joint engagement behaviors. Across four pre-intervention assessments, Participant G emitted an average of 25.3 instances of collaborative and joint engagement behaviors. During the final assessment, Participant G emitted 53 instances of collaborative and joint engagement behaviors. All three participants demonstrated small increases in collaborative and joint engagement behaviors when given a floor puzzle to complete with a peer.

Figure 10

Instances of Collaborative and Joint Engagement Behaviors During Floor Puzzle

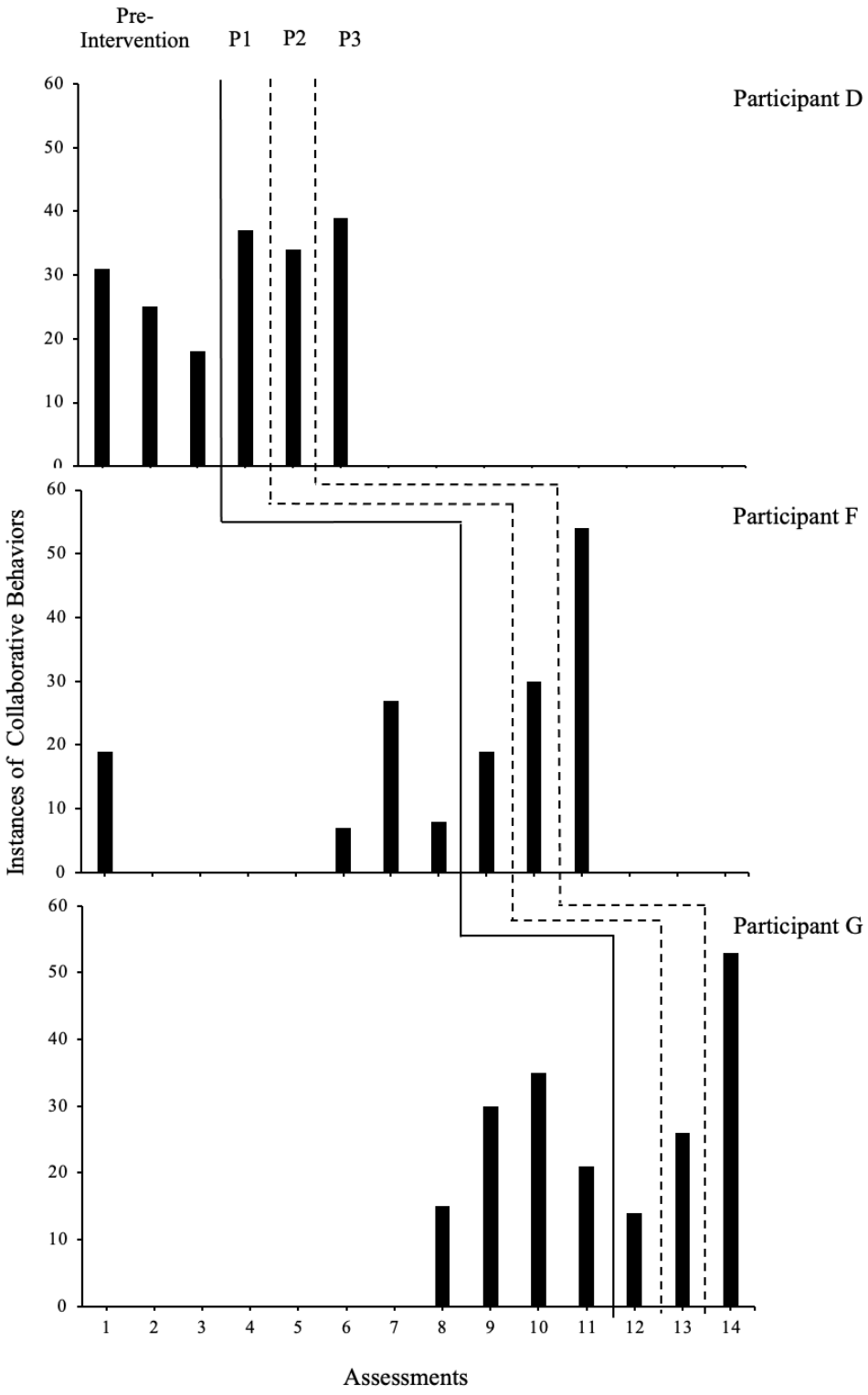


Figure 11 displays the vocal verbal operants emitted during a 5 min collaborative activity of a floor puzzle with a peer. Across three pre-intervention assessments, Participant D emitted an average of .67 echoics, 8.6 tacts, 4 mands, 1intraverbal, and 0 conversational units. Participant D emitted the most VVOs towards peers following the final phase of intervention, including mostly mands and tacts. Across four pre-intervention assessments, Participant F emitted on average, 2 echoics, 5.5 tacts, 1 mand, 2.25 intraverbals, and 0 conversational units. After the final phase of intervention, Participant F emitted 7 tacts and 7 intraverbals to her peer. Across four pre-intervention assessments, Participant G emitted on average, 1 echoic, 2.25 tacts, .25 mands, 1 intraverbal, and 0 conversational units. After the final phase of intervention, Participant G emitted 5 echoics, 9 tacts, 4 mands, and 1 intraverbal. Overall, the participants all demonstrated increases in vocal verbal operants emitted towards a peer throughout the 5 min observation.

Figure 11

Vocal Verbal Operants During Floor Puzzle

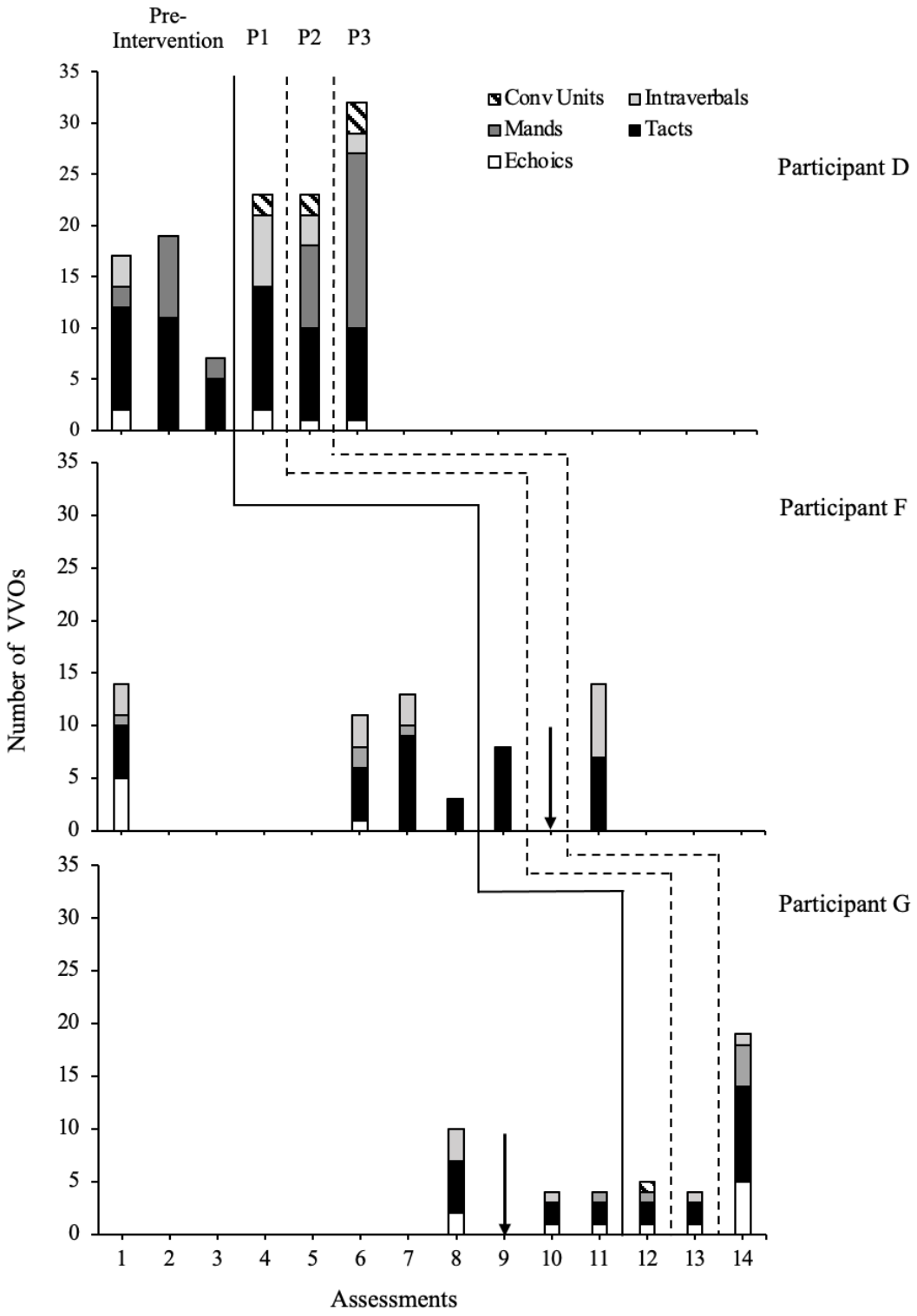
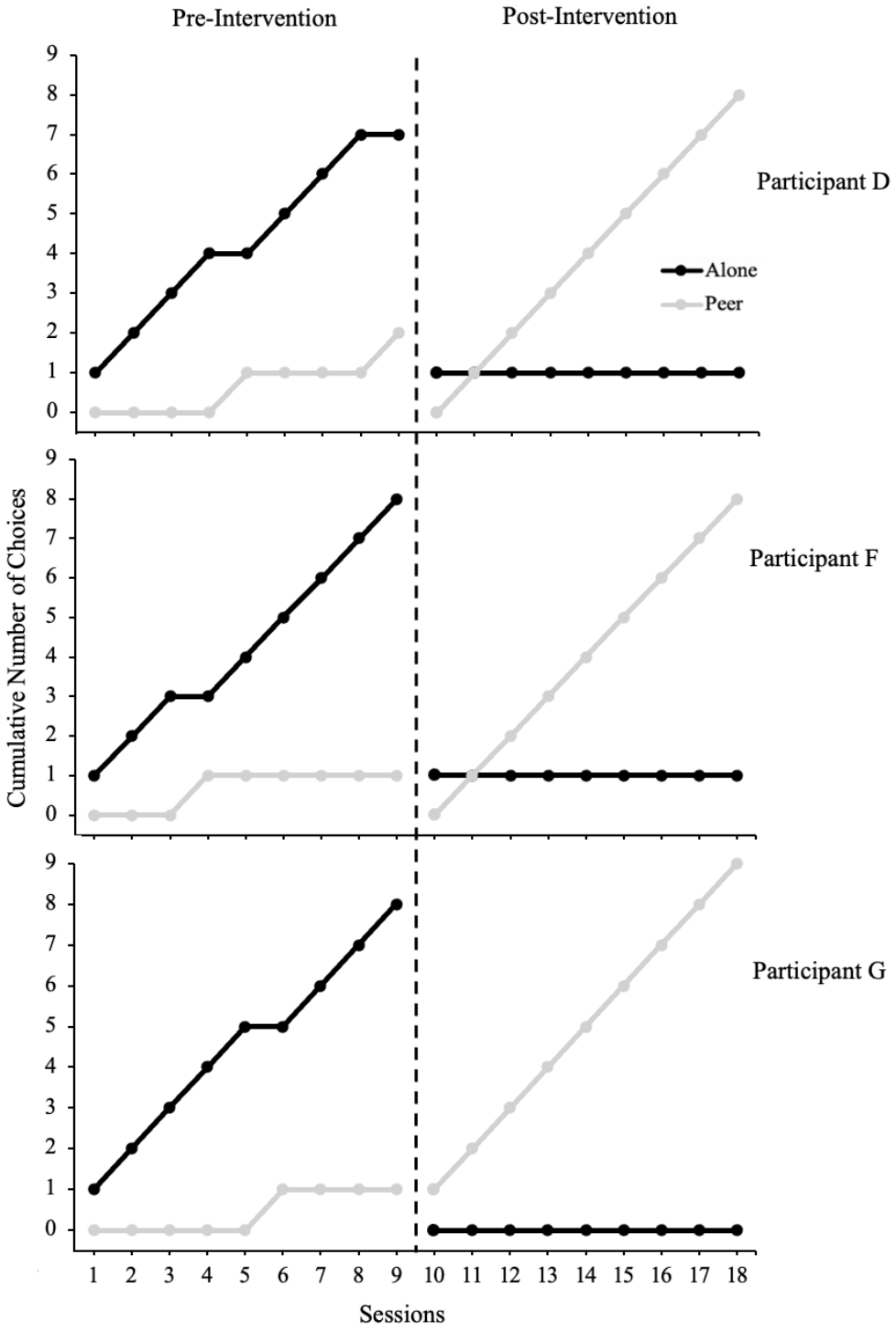


Figure 12 displays a cumulative record of the participants' preference to engage in an activity with a peer when given the opportunity to complete reading a book, coloring, or playing on the playground or indoor recess activity alone versus with a peer. The researchers gave participants a total of 9 opportunities to select completing an activity alone or with a peer. Prior to intervention, Participant D selected to complete an activity with a peer during 2 of 9 opportunities. Following intervention, Participant D increased to select to complete an activity with a peer to 8 of 9 opportunities. Prior to the intervention, Participant F selected to complete an activity with a peer during 1 of 9 opportunities. Following intervention, Participant F increased choices to complete an activity with a peer to 8 of 9 opportunities. Prior to intervention, Participant G selected to complete an activity with a peer during 1 of 9 opportunities. Following intervention, Participant G increased choices to complete an activity with a peer to 9 of 9 opportunities.

Figure 12

Cumulative Record of Participants' Choice to Engage in Activity Alone vs. With a Peer



Tables 12-14 display participants' raw scores and behavior levels for each social skill domain from both teacher forms and parent forms on the SSIS. According to the teacher form, Participant D increased behavioral levels from "below-average" to "average" across three social domains: communication, cooperation, and assertion and increased in all raw scores. According to the parent form, Participant D increased in raw data scores across social domains, however, maintained an "average" behavioral level throughout the study. According to the teacher form, Participant F increased in some social domains, however, there was more variability in these changes. Similarly, the results from the parent form show that Participant F increased in some social domains, however, she mostly maintained an "average" behavioral level. According to the parent form, Participant G increased in all social domains and maintained an "average" behavioral level. According to the teacher form, Participant G increased in all social domains and increased in most domains from "below-average" to "average."

Table 12

SSIS Participant D Teacher Form

	Pre-Intervention		Post-Intervention		Change
Social Skill Domains	**Raw Score**	**Behavior Level**	**Raw Score**	**Behavior Level**	
Communication	5	Below Average	11	Average	+6
Cooperation	6	Below Average	10	Average	+4
Assertion	6	Below Average	13	Average	+7
Responsibility	9	Average	12	Average	+3
Empathy	3	Below Average	5	Below Average	+2
Engagement	5	Below Average	9	Below Average	+4
Self-Control	10	Average	16	Average	+6

SSIS Participant D Parent Form

	Pre-Intervention		Post-Intervention		Change
Social Skill Domains	**Raw Score**	**Behavior Level**	**Raw Score**	**Behavior Level**	
Communication	15	Average	16	Average	+1
Cooperation	13	Average	12	Average	-1
Assertion	11	Average	13	Average	+2
Responsibility	9	Average	10	Average	+2
Empathy	12	Average	15	Average	+1
Engagement	15	Average	14	Average	+3
Self-Control	8	Average	12	Average	+4

Table 13

SSIS Participant F Teacher Form

	Pre-Intervention		Post-Intervention		Change
Social Skill Domains	**Raw Score**	**Behavior Level**	**Raw Score**	**Behavior Level**	
Communication	16	Average	14	Average	-2
Cooperation	15	Average	12	Average	-3
Assertion	2	Below Average	8	Below Average	+6
Responsibility	8	Below Average	12	Average	+4
Empathy	7	Below Average	11	Average	+3
Engagement	12	Below Average	11	Below Average	-1
Self-Control	7	Average	14	Average	+7

SSIS Participant F Parent Form

	Pre-Intervention		Post-Intervention		Change
Social Skill Domains	**Raw Score**	**Behavior Level**	**Raw Score**	**Behavior Level**	
Communication	19	Average	16	Average	-3
Cooperation	13	Average	13	Average	+0
Assertion	15	Average	19	Average	+4
Responsibility	13	Average	11	Average	-2
Empathy	15	Average	18	Above Average	+3
Engagement	16	Average	17	Average	+1
Self-Control	10	Average	11	Average	+1

Table 14

SSIS Participant G Teacher Form

	Pre-Intervention		Post-Intervention		Change
Social Skill Domains	**Raw Score**	**Behavior Level**	**Raw Score**	**Behavior Level**	
Communication	6	Below Average	13	Average	+7
Cooperation	9	Average	11	Average	+2
Assertion	3	Below Average	7	Below Average	+4
Responsibility	7	Below Average	12	Average	+5
Empathy	5	Below Average	14	Average	+9
Engagement	6	Below Average	14	Average	+8
Self-Control	8	Average	11	Average	+3

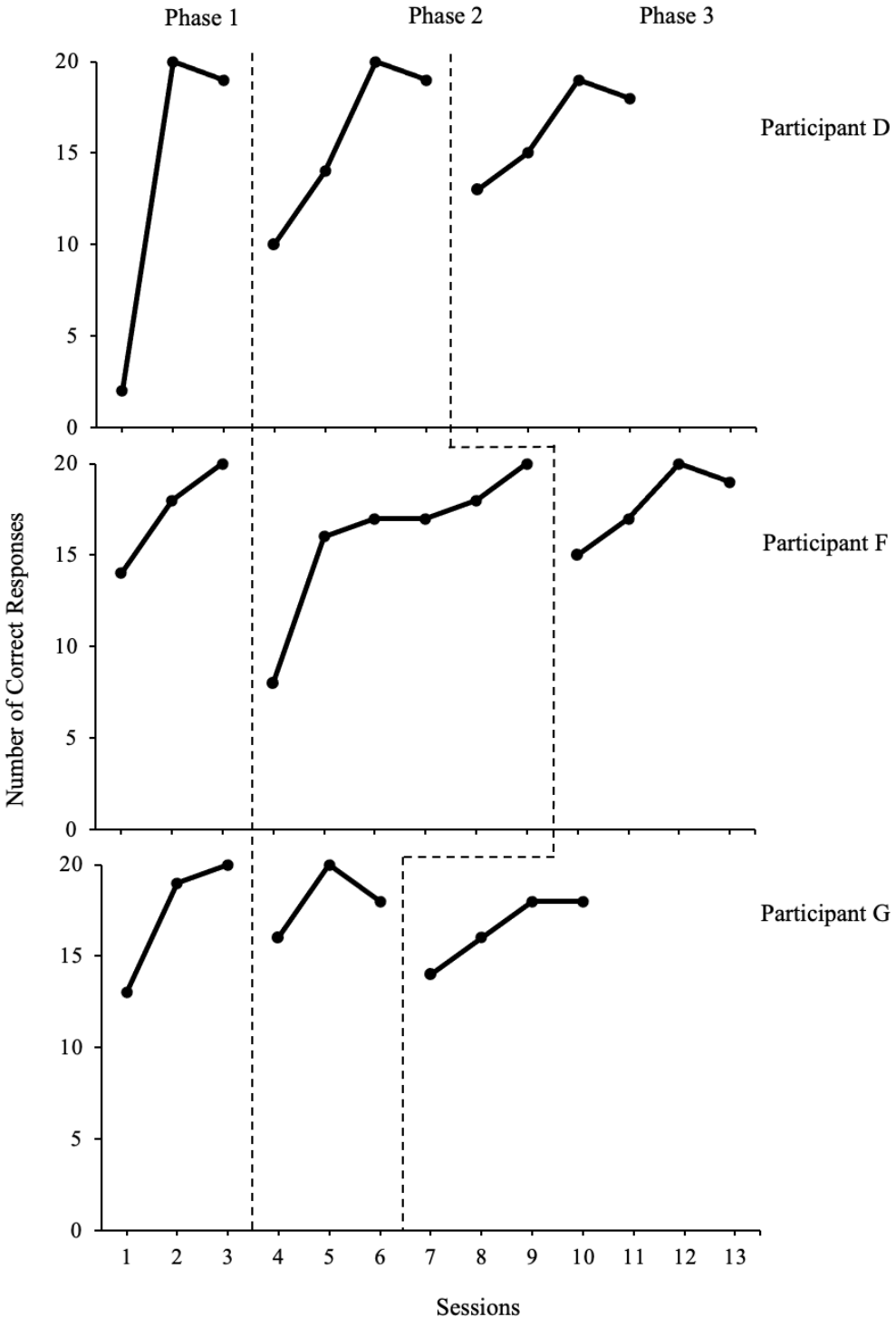
SSIS Participant G Parent Form

	Pre-Intervention		Post-Intervention		Change
Social Skill Domains	**Raw Score**	**Behavior Level**	**Raw Score**	**Behavior Level**	
Communication	14	Average	17	Average	+3
Cooperation	9	Average	10	Average	+1
Assertion	12	Average	15	Average	+3
Responsibility	9	Average	11	Average	+2
Empathy	11	Average	13	Average	+2
Engagement	12	Average	12	Average	+0
Self-Control	6	Average	7	Average	+1

Figure 13 displays the intervention graph for all participants. Participant D met criterion in phases 1, 2, and 3 in 3, 4, and 4 sessions, respectively. Participant F met criterion for phases 1, 2, and 3 in 3, 6, and 4 sessions, respectively. Participant G met criterion for phases 1, 2, and 3 in 3, 3, and 4 sessions, respectively. On average, the participants required about 3.8 sessions of each phase of intervention to meet mastery criterion of 90% accuracy across two consecutive sessions.

Figure 13

Intervention Graph for Experiment 2



3.3 Discussion

The purpose of this study was to establish conditioned reinforcement for collaboration for preschoolers with disabilities and measure changes in the participants' collaborative behaviors, vocal verbal behavior, LUC, and social skills. This experiment was similar to Experiment 1, however, Experiment 2's intervention was shortened with a less strict learning criteria and instead of measuring joint attention observing responses, the researcher used a social skills assessment to measure broader social changes. The results of this study indicate that participating in various collaborative activities with peers was an effective intervention in establishing collaboration as a reinforcer for three children, educationally classified as preschoolers with disabilities. In both experiments, the researchers conditioned the peer as a reinforcer through the intervention, which then joined a broader class of social reinforcement, and eventually, reinforcement for collaboration. Through the intervention, the participant received reinforcement contingent upon emitting the correct response with the peer (a collaborative behavior) to meet criteria. Therefore, the researcher used response contingent stimulus pairing to condition collaboration as a reinforcer in the participants (Dozier at al., 2020).

In Experiment 2, all three participants demonstrated an increase in the number of instances of collaborative behaviors with a peer from the first assessment to the final assessment when told "Do this puzzle together." After engaging in multiple different collaborative activities through the phases of intervention, participants demonstrated increases in working on a floor puzzle together, without ever being directly taught to work on puzzles together. According to the SSIS, all three participants showed mostly small increases in their social skills with peers, according to participants' parents and teachers. The learning measure demonstrated that the participants learned slightly faster with a peer following intervention. The participants learned to

work together towards a shared goal, as evident by increase in collaborative behaviors during a novel task (floor puzzle). The researcher implemented multiple collaborative activities where the participants were taught to communicate by serving as both a listener and speaker. This increase in communication skills was also evident in the increase in vocal verbal operants emitted during the floor puzzle for participants D and G, as participant F did not show any significant change.

Experiment 2 aimed to address some limitations from Experiment 1, such as, altering the learning assessment to make it more time-efficient for instruction, using the SSIS to measure social changes rather than just changes in joint attention, and adding a preference assessment to directly measure the participants' choice to engage in an activity with a peer or alone. Additionally, IOA was measured using trial-by-trial IOA for more precise interobserver agreement, and the second independent observer was trained in the definition of collaborative behaviors prior to coding the floor puzzle videos. Although Experiment 2 addressed many of the limitations described in the first experiment, there are still limitations to Experiment 2. Although the collaborative activities were completed in the hallway to minimize classroom distractions, there were still uncontrolled distractions in the hallway during the video recordings of the floor puzzle. For example, the participants may have become distracted if another teacher walked by, which could have led to some discrepancies in coding the instances of collaborative behaviors. Since this study was conducted in a preschool, there were some environmental factors that could not be completely minimized nor controlled, however, future researchers should consider how environmental distractors would affect efforts of collaboration.

Based on teacher observations in Experiment 2, there was a general increase in the participants' VVOs towards peers, sharing skills, cooperative play skills and overall social skills. Due to these anecdotal observations, future studies should attempt to target more generalized

instances of collaborative behaviors with peers throughout the schooldays. To do this, researchers could incorporate more observations throughout the day in non-instructional settings with various activities to partake in collaborative behaviors or consider student preferences towards certain activities. In both experiments, certain VVOs were counted as collaborative behaviors during the floor puzzle, including mands. However, not including other operants, such as intraverbals could be a limitation to both experiments.

Although the SSIS was intended to measurer broader social changes both at school and at home, it may not have demonstrated true effects due to discrepancy between parent and teacher assessments. This discrepancy may have been due to parents evaluating their child's social skills in the context of their parent-child relationship or within their family dynamic at home and not truly around other children. However, the teacher assessments at school were based off the participants' social interactions within the classroom around many peers in play time, recess, and throughout the day in instructional time. Therefore, the SSIS teacher reports may have reported a baseline that reflects fewer social behaviors when surrounded by many peers, while the parent reports reported typically higher baseline social behaviors, given the context in which parents assessed their child's behavior. Additionally, Participant F changed classrooms halfway through the study and therefore had a new teacher. This may have affected the SSIS teacher report as two different teachers completed the SSIS, one before and one after intervention.

Lastly, collaboration can be an ambiguous concept that incorporates various facets, like joint engagement, communication, active participation, problem-solving, cognitive skills, empathy, and cooperation. Due to the many variables that are said to be part of collaboration, there is not one sole definition of collaboration, and therefore, it was difficult to create an operational definition of collaborative behaviors for the floor puzzle activity. Additionally,

collaboration for a preschooler looks different than collaboration for a high school student. Future researchers could examine what collaborative behaviors "look like" in an activity given different definitions of collaboration across different student populations.

Chapter 4: General Discussion

In two experiments, I evaluated the effects of collaborative interventions that consisted of multiple collaborative activities on preschoolers with disabilities. Embedded within each activity was a peer-yoked contingency to reinforce collaborative behaviors with shared reinforcers. In Experiment 1, I evaluated the effects of the SLR protocol (Sterkin, 2012; Horton, 2020) on participants' collaborative behaviors, vocal verbal behavior, LUC for tacts or spelling words, and joint attention observing responses. Collaborative behaviors were defined as the participant taking a piece from peer, giving a piece to peer, manding for piece or help from peer, placing the piece together. The results of the first experiment demonstrated that all participants increased their number of collaborative behaviors while completing a floor puzzle with a peer. Similarly, the participants increased their vocal verbal operants towards their peers during this activity. Although two of the three participants showed faster learning in a collaborative contingency following intervention, there was some variability within these results. The results from the C-JARS and ELCAR joint attention measures showed an increase in participants' joint attention observing responses towards peers. However, the measure did not capture any broader positive social changes with other classmates. Further, Experiment 1 identified that the learning measure was time consuming to conduct and taxing on both student learning and instructional time in the classroom. Therefore, Experiment 1 established the need to further investigate the effects of an intervention on collaborative behaviors and the collateral effects on participants' learning, social skills, and preference to engage in activities with peers.

Experiment 2 evaluated the effects of a shortened, more concise intervention on participants' collaborative and joint engagement behaviors, vocal verbal behavior, preference to select activities alone versus with a peer, and broader social changes. Potentially most

importantly, results from Experiment 2 found that after participating in the intervention, the participants chose to engage in activities with a peer when given the opportunity to do something alone or with a peer. In other words, the participants selected out friends to do things with and increased socialization within the classroom. The results from both experiments support that educators can establish reinforcement for collaboration and this reinforcer selects out a range of prosocial and collaborative behaviors, even with preschoolers with disabilities.

4.1 Major Findings

4.1.1 Collaborative Behaviors and Vocal Verbal Behavior

Both experiments demonstrated that the establishment of collaboration as a reinforcer can increase preschoolers' instances of collaborative and joint engagement behaviors and vocal verbal operants when told to complete a floor puzzle to complete together. Prior to the participants entering intervention, they all emitted lower instances of collaborative behaviors and emitted few appropriate vocal verbal operants towards their peers. However, once collaboration was established as a reinforcer, the participants demonstrated more instances of collaboration with joint engagement and more appropriate vocal operants with their peers. The results from these experiments align with results from Pianesi et al. (2009) where the researchers used a collaborative puzzle game to develop collaboration and increase social skills in children with ASD.

4.1.2 Learn Units to Criterion

In Experiment 2, the researcher measured participants' rate of learning with a peer prior to intervention and following intervention. The results demonstrated that across the participants, there was a decrease in the number of learn units required to master the learning criteria following the intervention. However, it is noteworthy to mention that across both experiments,

the effects on learning were small and inconsistent. Additionally, this measure was a pre- and post- measure to account for instructional time within the classroom. Due to the impracticability of a repeated learning measure, the design is a potential limitation to acknowledge. However, the results from these experiments support the idea that once collaboration is established as a reinforcer, it serves as a verbal behavior developmental cusp, which means that students can learn faster once it is acquired. Because collaboration was established as a reinforcer, the participants learned to tact pictures with a peer in fewer sessions. The researchers taught the participants to be sensitive to the behaviors of their peers and further demonstrated observational stimulus control, meaning that they learned faster with a peer when they acquired reinforcement for collaboration, and attended to their peer (Greer et al., 2024). This variable is important to acknowledge as literature supports that when students work collaboratively, rather than independently, they perform better academically too (Fawcett & Garton, 2005). Therefore, teaching children to collaborate not only demonstrates positive social interactions, language, and collaborative behaviors, but also better learning.

4.1.3 Preference to Engage in Activity Alone or With Peer

The preference assessment in Experiment 2 was used to determine a shift in the participants' choice to complete a variety of activities alone or with a friend. The results from Experiment 2 demonstrated that following a collaborative intervention, all three participants selected to engage in activities with their peers, instead of completing things alone. This measure further supported that the participants demonstrated reinforcement for collaboration, meaning that they wanted to do things with their peers, or it was more reinforcing than doing things alone.

4.1.4 Joint Attention and Social Skills

The joint attention measures in Experiment 1 showed mostly positive increases in the participants' joint attention observing responses towards peers, as observed by both parents and teachers. More specifically, participants' prosocial behaviors increased while their asocial behaviors decreased. Although these were positive findings, the researcher acknowledged anecdotal social changes and increases in positive peer interactions. Therefore, in Experiment 2, the SSIS was intended to measure broader social changes across various social domains, including communication, cooperation, and engagement. Results from Experiment 2 demonstrated mostly positive effects across participants, according to both parent and teacher reports. Although generally positive, the results were variable across participants.

4.2 Limitations and Future Research

4.2.1 Experiment 1

First, there were some limitations to the LUC measures. In Experiment 1, only two of the three participants demonstrated increases in their speed of learning in the collaborative contingency. Participant B demonstrated the same average LUC across both conditions in the post-intervention assessments. Further, due to the amount of instructional time and instructional effort required to conduct these assessments, Participants A and C only completed one pre-intervention assessment in the collaborative contingency and Participant C did not meet criterion in the post-intervention assessment in the individual contingency. To fully contribute to evidence of reinforcement for collaboration as a verbal behavior developmental cusp, future researchers should adapt this learning measure to demonstrate more significant changes in the LUC in group instruction. It is also noteworthy to consider the learning conditions and ways to improve upon the structure and efficiency of the assessment. Specifically, the assessments took a significant amount of instructional time and could be revised to promote efficiency.

Additionally, it is important to acknowledge that the participants' collaborative behaviors and vocal operants were only recorded for 5 min during the floor puzzle. There is a possibility that if the sample was a longer duration, the researchers may have seen more collaborative behaviors and vocal operants emitted. Similarly, the researchers only used a floor puzzle to measure the participants' instances of collaboration and vocal behavior. Although the puzzles varied across assessments, there may have been some missing prerequisites towards completing jigsaw puzzles. Interestingly, classroom staff anecdotally observed an increase in collaborative behaviors throughout the day and across various activities with multiple classmates.

Future research should consider expanding the 5 min time sample and the activities selected for the participants to include their preferred items of interest. Along with considering the participants' preferred interests, the researchers observed more instances of collaboration with alphabet puzzles, compared to other puzzles used throughout the collaboration assessments. The selection of the puzzle may play a role in the reinforcement value of the puzzle which may have affected the likelihood of participants choosing to collaborate with their peer.

In both the ELCAR joint attention observing responses measure and C-JARS, the participants could only score up to 4. Although there were increases in the joint attention measures in this experiment, future research could consider stronger ways to capture overall positive changes in peer interactions and joint engagement through reinforcement for collaboration. Additionally, because the participants attended a preschool, they all also received related services, such as speech therapy or occupational therapy, in which some sessions may have been in a group setting. This is important to recognize that other factors may have also led to increases in joint attention and collaborative instances, outside of solely the intervention.

4.2.2 Experiment 2

Experiment 2 further demonstrated that educators could establish and improve reinforcement for collaboration in young children with disabilities and promote their social and communication skills with peers. The results demonstrated increases in the participants' collaborative and joint engagement behaviors during a floor puzzle. Although Experiment 1 showed a larger effect in the increase of vocal verbal operants to peers than in Experiment 2, there was not large increases among the participants' vocal verbal operants across both experiments. Future research could measure vocal verbal operants in a more naturalistic way, and more frequently throughout the school day. Both the participants' parents and teacher also reported increases in their social skills based off the SSIS. Like Experiment 1, it was noted that the participants demonstrated positive social changes in their daily interactions with peers, service providers, and teachers, according to anecdotal observation. Although this study increased participants' reinforcement for collaboration, the SSIS measure was limited in what changes in social skills were measured. Therefore, researchers could measure reinforcement for collaboration more directly in the future. Based off the social skill domains in the SSIS, it could be expected that the participants would demonstrate most positive changes in the cooperative, engagement and communication domains, as they all relate closely to dependent variables in this study. Although there were mostly increases in those domains, it was not consistent across all participants. Some everyday positive social interactions were not captured in Experiment 2 and researchers should aim to measure those.

This study contributed to the literature on collaboration as a reinforcer, however, more research should be conducted to expand the empirical studies in this field of research. It would be beneficial for researchers to investigate collaborative behaviors in other contexts, besides a floor puzzle, due to some limitations of the activity itself. It is also important to note that all

participants' assessments were conducted with the same peer that they went through intervention with. This may have produced positive social results in which the children became friends within the classroom. This finding is similar to Horton (2020) where the researcher found that children can benefit from working with a peer and engaging in experiences that require them to function as a speaker and listener. However, future research could expand these findings and measure changes with different classmates to ensure generalizability of reinforcement for collaboration across different children. Researchers could use multiple exemplars of peers across different activities to promote more collaboration with more children.

It is noteworthy to recognize the difference in participants' verbal behavior developmental level from Experiment 1 to Experiment 2. Experiment 1 consisted of participants in a self-contained classroom with less self-management, academic, and age-appropriate communication skills. However, the participants in Experiment 2 were in less restrictive classrooms with higher ratios and demonstrated more complex verbal behavior cusps. This may explain the difference of collaborative behaviors and vocal verbal operants in baseline during the collaborative activity for participants in each experiment. Additionally, it is important to make note of the disadvantage of conducting IOA with low numbers when measuring the instances of collaborative and joint engagement behaviors. For example, if one observer measured three instances while the other observer measured 4 instances during the 5 min observation, it is a mathematical problem that makes the average low, at 75%, when the independent observers are truly only one instance off from one another, out of the 60 opportunities.

Both experiments involved multiple components in the interventions and were designed in the sequence to build upon previous skills and expand to lead up to collaborative behaviors. For example, in the first phase, "I-Spy," the participant is just required to respond as a listener to

the peer to emit a correct response. Then, in the peer tutoring phase, the participant is required to act as both a listener and speaker to respond to the peer's antecedent correctly. In the final phase, block construction, the participant has then learned to emit intraverbals, deliver learn units, and contact reinforcement through the peer-yoked contingency, to condition reinforcement for collaboration. Although there is rationale for each phase and sequence of the intervention, we cannot state with certainty which phases were necessary, and which were sufficient to see the results. Therefore, component analyses could be conducted to examine which specific phases of the intervention are most crucial to increase the efficiency of the intervention.

4.3 Educational Implications

Both studies' results showed that teaching children to collaborate through various collaborative activities where they contact reinforcement by working on some activity together resulted in an increase in collaborative behaviors, vocal verbal operants, learning in a dyad with a peer, and a preference to engage in a variety of activities with a peer. These results suggest that educators can create learning environments in which children can learn to enjoy working together and build collaborative behaviors early on. In special education, there has been a drive to prepare students for inclusion classrooms and place students in the least restrictive environments. Inclusive education involves placing students with disabilities in general education classrooms along with their typically developing peers (Kart & Kart, 2021). Research supports that there are many benefits to inclusive education, including improved communication skills, social interactions, and academic achievement (Wehmeyer et al, 2021). The goal for most teachers, service providers, parents, and administrators has been to get students with disabilities to a point where they are ready to succeed in a general education classroom, both academically and socially.

It is important for children to learn to communicate effectively, problem-solve, and work together to collaborate. Preschoolers with positive social skills are more successful in performing tasks such as listening, following classroom rules, and participating in activities with others. Further, when they lack social skills, they often demonstrate communication problems, problem behaviors, and school failure (Aksoy, 2021). Based off these two experiments, when preschoolers with disabilities learn the necessary reinforcers to collaborate with their peers, they demonstrate an increase in social skills. Additionally, they are more likely to learn faster in group instruction, work appropriately with other children, communicate effectively, and engage in activities appropriately with their peers. All these behaviors are important to succeed in a general education classroom. Therefore, there is educational importance to teaching young children with disabilities how to work with one another to set them up for success in their least restrictive environments.

Literature suggests that as early on as three years old, children begin to collaborate and develop a sense of "we." Moreso, the partnership that young children start to sense often comes from interdependent collaborative activities (Vasil & Tomasello, 2022). The results of these two experiments demonstrated that the use of interdependent collaborative activities could increase collaborative and joint engagement behaviors in young children. These results further suggest that educators could incorporate collaborative games into instruction to help promote collaboration early on.

Conclusion

Across two experiments, I investigated the effects of establishing reinforcement for collaboration across multiple collaborative activities on participants' preference to work with another peer, collaborative behaviors and vocal verbal behavior during a 5 min floor puzzle

observation, learning with a peer, and changes in social skills and joint attention reported by the participants' parent and teacher. The results showed that when young children engage in multiple collaborative activities that include reinforcement for collaboration, they can be taught to enjoy working with one another. When they learned that working together on something is more reinforcing than working alone, they demonstrated more instances of collaborative and joint engagement behaviors, appropriate vocal verbal communication, positive social skills, faster learning with peers, and selected to engage in activities with their peers. Educators can teach children with disabilities to collaborate with their peers early on and set them up for success in their least restrictive environments. Collaboration is a required skill for children and adults to partake in and there is social significance to collaboration throughout the duration of our entire lives (Child & Shaw, 2016).

References

Aksoy, P. (2021). A classroom-based training program involving preschool children for developing prerequisite learning skills and social skills: ready to learn. *Adiyaman University Journal of Educational Sciences, 11*(2), 107-124. http://doi.org/10/17984/adyuebd.709921

Baker, M. J. (2015). Collaboration in collaborative learning. *Interaction Studies*, *16*(39), 451–473. https://doi.org/10.1075/is.16.3.05bak

Barfield, A. (2016). Collaboration, *ELT Journal, 70* (2), 222 – 224. https://doi.org/10.1093/elt/ccv074

Barrish, J., Saunders, M., & Wolf, M. (1969). Good behavior game: effects of individual contingencies for group consequences on disruptive behavior in a classroom. *Journal of Applied Behavior Analysis*, *2*(2), 119–124. https://doi.org/10.1901/jaba.1969.2-119

Bolich, B. J. (2001). Peer tutoring and social behaviors: a review. *International Journal of Special Education. 16* (2), 16-30.

Bowman-Perrott, L., Burke, M. D., Zhang, N., & Zaini, S. (2014). Direct and collateral effects of peer tutoring on social and behavioral outcomes: a meta-analysis of single-case research. *School Psychology Review, 43*(3). https://doi.org/10.1080/02796015.2014.12087427

Catrone, R. G., Baires, N. A., Martin, M. R., Brown-Hollie, J. P. (2023). An intersectional examination of disability and race models in behavior-analytic practice. *Behavior and Social Issues, 32,*152-181. https://doi.org/10.1007/s42822-022-00116-z

Carriveau, T., Muething, C. S., & Trapp, W. (2020). Interpersonal and group contingencies. *Perspectives on Behavior Science, 43*(1), 115-135. https://doi.org/10.1007/s40614-020-00245-z

Child, S. & Shaw, S. (2016). Collaboration in the 21st century: Implications for assessment. *Research Matters,* 17-22. https://doi.org/10.17863/CAM.100344

Chow, J. C., & Gilmour, A. F. (2016). Designing and implementing group contingencies in the classroom: A teacher's guide. *Teaching Exceptional Children, 48*(3), 137-143. https://doi.org/10.1177/0040059915618197

Cook, L. & Friend, M. (1991). Principles for the practice of collaboration in schools. *Preventing School Failure: Alternative Education for Children and Youth*, *35*(4), 6-9. http://doi.org/10.1080/1045988X.1991.9944251

Cook, L., & Friend, M. (2010). The state of the art of collaboration on behalf of students with disabilities. *Journal of Educational and Psychological, 20*(1), 1-8. http://doi.org/10.1080/10474410903535398

Cooper J. O., Heron T. E., & Heward, W.L. (2020). *Applied Behavior Analysis* (3rd ed.). Pearson Education.

Darcy, L. (2017) The identification and establishment of reinforcement for collaboration in elementary students. Unpublished doctoral dissertation, Columbia University Teachers College.

Davies-Lackey, A. (2005). Yoked peer contingencies and the acquisition of observational learning repertoires. Unpublished doctoral dissertation, Columbia University Teachers College.

Degotardi, S. (2017). Joint attention in infant-toddler early childhood programs: its dynamics and potential for collaborative learning. *Contemporary Issues in Early Childhood, 18*(4), 355-444. https://doi.org/10.1177/1463949117742786

Downs, A. & Smith, T. (2004). Emotional understanding, cooperation, and social behavior in high-functioning children with Autism. *Journal of Autism and Developmental Disorders,34,* 625-635. https://doi-org.ezproxy.cul.columbia.edu/10.1007/s10803-004-5284-0

Dozier, C.L., Foley, E.A., Goddard, K.S. & Jess, R.L. (2025). Reinforcement. In The Encyclopedia of Child and Adolescent Development (eds S. Hupp and J. Jewell). https://doi.org/10.1002/9781119171492.wecad062

Fantino E. (2008). Choice, conditioned reinforcement, and the prius effect. *The Behavior Analyst*, *31*(2), 95–111. https://doi.org/10.1007/BF03392164

Fawcett, L. M., & Garton, A. F. (2005). The effect of peer collaboration on children's problem-solving ability. *British Journal of Educational Psychology, 75*(2), 157–169. https://doi-org.tc.idm.oclc.org/10.1348/000709904X23411

Fiore, S. M., Gresser, A., Greiff, S., Griffin, P., Gong, B., Kyllonen, P. C., Massey, C., O'Neil, H., Pellegrino, J., Rothman, R., Soule, H., & von Davier, A.A (2017). *Collaborative problem solving: Considerations for the national assessment of education progress.* National Center for Education Statistics

Friend, M. (1990). Collaboration as a predictor for success in school reform. *Journal of Educational and Psychological Consultation, 1*(1), http://doi.org/10.1207/s1532768xjepc0101_4

Gentilini, L. M., & Greer, R. D. (2020). Establishment of conditioned reinforcement for reading content and effects on reading achievement for early-elementary students. *The Psychological Record, 70*(2), 327–346. https://doi-org.tc.idm.oclc.org/10.1007/s40732-020-00382-6

Greenwood, C. R., Hops, H., Delquadri, J., & Guild, J. (1974). Group contingencies for group consequences in classroom management: a further analysis. *Journal of Applied Behavior Analysis, 7*(3), 413-425. https://doi.org/10.1901/jaba.1974.7-413

Greenwood, C.R., Maheady, L., & Delquadri, J. (2022). Class wide peer tutoring programs. In M. R. Shinn, H. M. Walker, & G. Stoner (Eds.), *Interventions for academic and behavior problems II: Preventive and remedial approaches* (pp. 611–649). National Association of School Psychologists.

Greer, R.D. (2002). *Designing teaching strategies: An applied behavior analysis systems approach*. San Diego, California: Academic Press.

Greer, R. D., Dudek, J., Chang, H. (2024). Observation, language learning, and development: the verbal behavior development theory. *The Psychological Record, 74*, 541-554. https://doi.org/10.1007/s40732-024-00585-1

Greer, R. D., & Ross, D. E. (2008). Verbal Behavior Analysis: Inducing and Expanding Complex Communication in Children with Severe Language Delays. Boston: Allyn & Bacon.

Greer, R.D, Singer-Dudek, J., & Gautreaux, G. (2006). Observational learning. *International Journal of Psychology, 41*(6), 486 – 499. https://doi-org.tc.idm.oclc.org/10.1080/00207590500492435

Greer, R. & Pohl, Peter & Du, Lin & Moschella, J. (2017). The Separate development of children's listener and speaker behavior and the intercept as behavioral metamorphosis. *Journal of Behavioral and Brain Science, 7*(13), 674-704. http://doi.org/10.4236/jbbs.2017.713045

Greer, R. D. (2020). The selector in behavior selection. *The Psychological Record, 70,* 543- 558. https://doi.org/10.1007/s40732-020-00385-3

Greer, R. D., Speckman, J., Dudek, J., Cahill, C., Weber, J., Du, L., & Longano, J. (2023). Early Learner Curriculum Achievement Record.

Horton, J. (2020). The effects of the social-listener protocol on the observing, helping, and vocal behavior of children with ASD. Unpublished doctoral dissertation, Columbia University Teachers College.

Humphrey, N., & Symes, W. (2011). Peer interaction patterns among adolescents with autistic spectrum disorders (ASDs) in mainstream school settings. *Autism*, *15*(4), 397-419. https://doi.org/10.1177/1362361310387804

Jones, S., Peter, C. ., & Ruckle, M.M. (2020). Reporting of demographic variables in the journal of applied behavior analysis. *Journal of Applied Behavior Analysis, 53*(3), 1304-1315. http://doi.org/10.1002/jaba.722

Ladd, G. W., Herald, S. L., & Kochel, K. P. (2006). School readiness: Are there social prerequisites? *Early Education and Development*, *17*(1), 115–150. https://doi.org/10.1207/s15566935eed1701_6

Ladd, G., Ladd, B., Visconti, K., Ettekal, I., Sechler, C., & Cortes, K. (2013). Grade-school children's social collaborative skills: Links with partner preference and achievement. *American Educational Research Journal. 51*(1), 152-183. http://doi.org/10.3102/0002831213507327

Kart, A. & Kart, M. (2021). Academic and social effects of inclusion on students without disabilities: a review of the literature. *Education Sciences, 11*(1). https://doi.org/10.3390/educsci11010016

Kato, D., Hattori, K., Iwai, S., & Morita, M. (2012). Effects of collaborative expression using Lego® blocks, on social skills and trust. *Social Behavior and Personality: An International Journal, 40*(7), 1195–1199. https://doi.org/10.2224/sbp.2012.40.7.1195.

Kelleher, R. T. & Gollub, L. R. (1962). A review of positive conditioned reinforcement. *Journal of Experimental Analysis of Behavior*, *5*(4), 543-97. http://doi.org.10.1901/jeab.1962.5-s543

Laal, M., & Laal, M. (2012). Collaborative learning: What is it? *Procedia - Social and Behavioral Sciences*, *31*, 491–495. https://doi.org/10.1016/j.sbspro.2011.12.092

Ladd, G. W., Kochenderfer-Ladd, B., Visconti, K-J., Ettekal, I., Sechler, C. M., Cortes, K. (2014). Grad-school children's social collaborative skills: links with partner preference and achievement, *American Educational Research Journal, 51*(1), 152-183. http://doi.org.10.3102/0002831213507327

Lawson, T. R. & Trapenberg, G. (2007). The effects of implementing a class wide per tutoring model on social approvals and disapprovals emitted during unstructured free time. *Journal of Early and Intensive Behavior Intervention, 4*(2), 471-482.

Lawson, T. R. & Walsh, D. (2007). The effects of observational training on the acquisition of reinforcement for listening. *Journal of Early and Intensive Behavior Intervention, 4*(2), 430-452. https://doi-org.tc.idm.oclc.org/10.1037/h0100383

Luna, O., Petri, J. M., & Nuhu, N. (2023). Addressing racial disparities in behavior-analytic services: Provider and trainee awareness, competency, and systemic action. *Behavior and Social Issues, 32*(1), 249–273. https://doi-org.tc.idm.oclc.org/10.1007/s42822-022-00117-y

Mackay, T., Knott, F., & Dunlop, A. (2007). Developing social interaction and understanding in individuals with autism spectrum disorder: a groupwork intervention. *Journal of Intellectual and Developmental Disability, 32*(4), 279-290. https://doi.org/10.1080/13668250701689280

Madden, G. J., Mahmoudi, S., & Brown, K. (2023). Pavlovian learning and conditioned reinforcement. *Journal of Applied Behavior Analysis*, *56*(3), 498–519. https://doi.org/10.1002/jaba.1004

Maffei, J., Singer-Dudek, J., & Dolleen-Day, K. (2014). The effects of the establishment of adult faces and/or voices as conditioned reinforcers for children with ASD and related disorders. *Acta de Investigación Psicológica, 4,* 1621-1641.

Morrier, M. J., & Ziegler, S. M. T. (2018). I wanna play too: Factors related to changes in social behavior for children with and without autism spectrum disorder after implementation of a structured outdoor play curriculum. *Journal of Autism and Developmental Disorders, 48*(7), 2530–2541. https://doi. org/10.1007/s10803-018-3523-z

O'Madagain, C. & Tomasello, M. (2019). Joint attention to mental content and the social origin of reasoning. *Synthese, 198*, 4057-4078. https://doi.org/10.1007/s11229-019-02327-1

Pigott, H. E.,Fantuzzo, J. W., & Clement, P. W. (1986). The effects of reciprocal peer tutoring and group contingencies on the academic performance of elementary school children. *Journal of Applied Behavior Analysis, 19*(1), 93-98. https://doi.org/10.1901/jaba.1986.19-93

Polat, O., Sezer, T., & Akyol, N. A. (2022). Collaborative learning with mind mapping in the development of social skills of children. *Participatory Educational Research, 9*(1), 463-480. http://doi.org/10.17275/per.22.25.9.1

Poysa-Tarhonen, J., Awwal, N., Hakkinen, P., & Otieno, S. (2021). Joint attention behavior in remote collaborative problem solving: exploring different attentional levels in dyadic interaction. *Research and Practice in Technology Enhanced Learning, 16*(11). https://doi.org/10.1186/s41039-021-00160-0

Raulston, T. J., Ousley, C. L., Hinton, E.M., & Ramirez, A. M. (2024). Beyond trial counts: considerations for measuring play and engagement during early intervention. *Behavior Analysis in Practice,* https://doi.org/10.1007/s40617-024-01002-3

Rothstein, M. B. & Gautreaux, G. G. (2007). The Effects of a peer-yoked contingency on observational learning and the collateral emergence of naming. *Journal of Early and Intensive Behavior Intervention, 4*(2), 453-470.

Roschelle, J., & Teasley, S.D. (1995). The construction of shared knowledge in collaborative problem solving. In: O'Malley, C. (Eds.) *Computer Supported Collaborative Learning*. 69-97. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-85098-1_5

Seo, E. & Kim, M. (2019). The effect of peer tutoring for college students: who benefits more from peer tutoring, tutors, or tutees? *The New Educational review, 58*(4), 97. http://doi.org/10.15804/tner.2019.58.4.07

Silveria-Zaldivar, T., Ozerk, K., & Ozerk, G. (2021). Developing social skills and social competence in children with autism. *International Electronic Journal of Elementary Education, 13*(3), 341-363. http://doi.org/10.26822/iejee.2021.195

Singer-Dudek, J., Oblak, M., & Greer, R. D. (2011). Establishing books as reinforcers for preschool children as a function of an observational intervention. *Journal of Applied Behavior Analysis*, *44*, 421-434. https://doi.org/10.1901/jaba.2011.44-421

Singer-Dudek, J., Speckman, J., & Nuzzolo, R. (2010). A comparative analysis of the CABAS® model of education at the Fred S. Keller School: A twenty-year review. *The Behavior Analyst Today, 11*(4), 253–265. https://doi-org.tc.idm.oclc.org/10.1037/h0100705

Singer-Dudek, J., Keohane, D.-D., & Matthews, K. (2021). Educational systems administration: The comprehensive application of behavior analysis to schooling (CABAS®) model. In A. Maragakis, C. Drossel, & T. J. Waltz (Eds.), *Applications of behavior analysis in healthcare and beyond* (pp. 369–387). Springer Nature Switzerland AG. https://doi-org.tc.idm.oclc.org/10.1007/978-3-030-57969-2_17

Skinner (1957). Verbal Behavior: Appleton-Century-Crofts. https://doi-org.tc.idm.oclc.org/10.1037/11256-000

Skopeliti, I. & Riga, A. (2021). Collaborative learning and its positive impact in the cognitive development of children with learning disabilities. *Current Research in Language, Literature, and Education*. http://doi.org/10.9734/bpi/crlle/v2/15108D

Staats, A. W., Staats, C. K., Schutz, R. E., & Wolf, M. (1962). The Conditioning of textual responses using "extrinsic" reinforcers. *Journal of the Experimental Analysis of Behavior*, *5*, 33-40. https://doi.org/10.1901/jeab.1962.5-33

Sterkin,V. L. (2012). The effects of the social listener reinforcement protocol on the audience control of stereotypy and social operants for students with developmental delays. Unpublished doctoral dissertation, Columbia University Teachers College.

Stolfi, L. (2005). The induction of observational learning repertoires in preschool children with developmental disabilities as a function of peer-yoked contingencies. Unpublished doctoral dissertation, Columbia University Teachers College.

Thurston, A., Cockerill, M., & Chiang, T-H. (2021). Assessing the differential effects of peer tutoring for tutors and tutee. *Education Sciences, 11*(3). https://doi.org/10.3390/educsci11030097

Tomasello, M. (1999). The cultural origins of human cognition. Harvard University Press.

Tomasello, M. (2016). Cultural learning redux. *Child development, 87*(3). https://doi.org/10.1111/cdev.12499

Tsai, H., & Greer, R. D. (2006). Conditioned preference for books and faster acquisition of textual responses by preschool children. *Journal of Early and Intensive Behavioral Interventions*, *3*, 35-60. https://doi.org/10.1037/h0100322

Vasil, J. & Tomasello, M. (2022). Effects of "we"-framing on young children's commitment, sharing, and helping. *Journal of Experimental Child Psychology, 214,* https://doi.org/10.1016/j.jecp.2021.105278

Veldman, M. A., Doolaard, S., Bosker, R. J., & Snijders, T.A.B. (2020). Young children working together. Cooperative learning effects on group work of children in grade 1 of primary education. *Learning and Instruction, 67*(1), 1-13. https://doi.org/10.1016/j.learninstruc.2020.101308

Wehmeyer, M.L., Shogren, K. A., & Kurth, J. (2021). The state of inclusion with students with developmental disabilities in the United States. *Journal of Policy and Practice in Intellectual Disabilities, 18*(1), 36-43. https://doi.org/10.1111/jppi.12332

Wishart, J. G., Willis, D. S., Cebula, K. R., & Pitcairn, T. K. (2007). Collaborative learning: comparison of outcomes for typically developing children and children with intellectual disabilities. *American Journal on Mental Retardation, 112*(5), 361-374. http://doi.org/10.1352/0895-8017

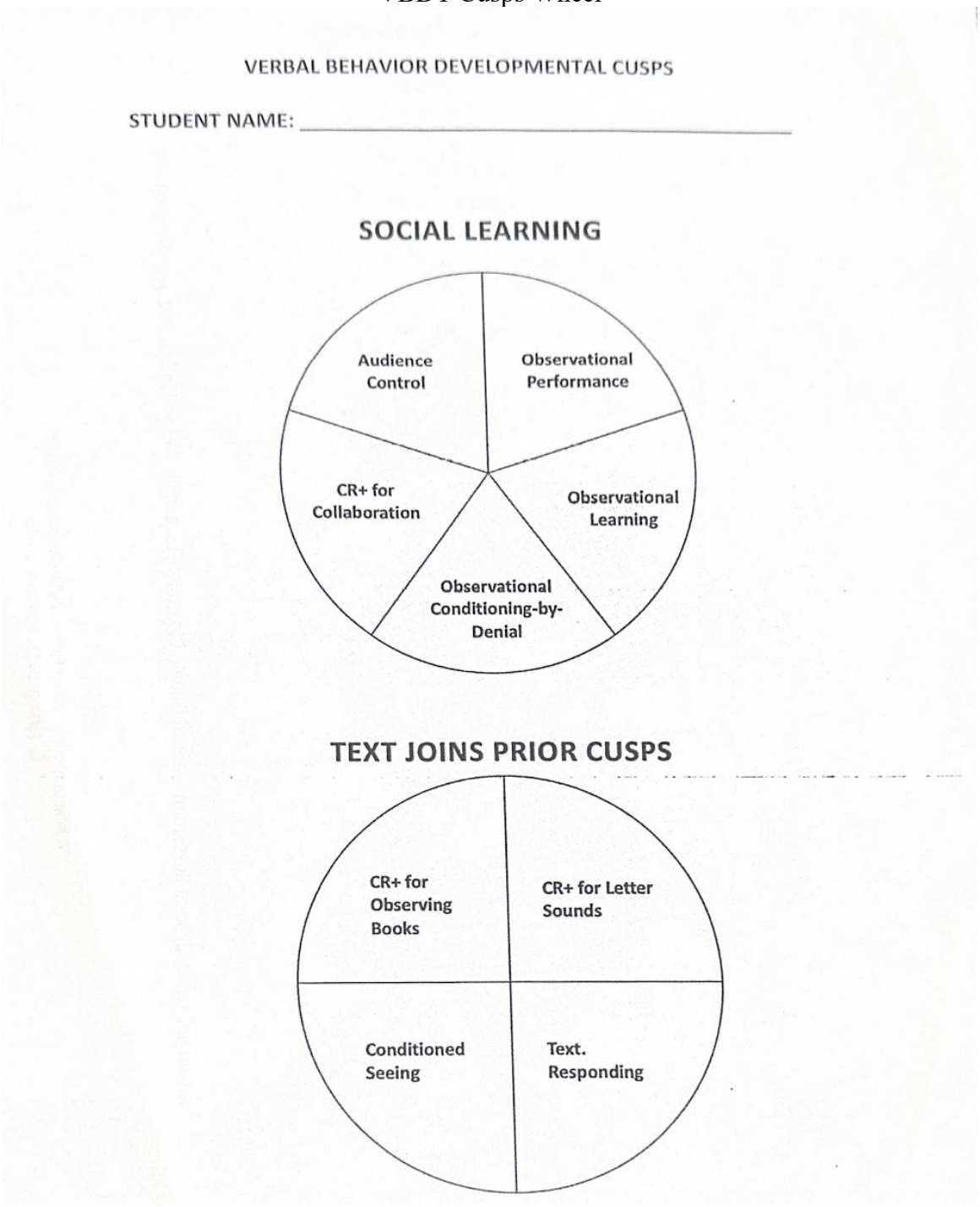
Xu, Y., Gelfer, J. I., Sileo, N., Filler, J., Perkins, P. G. (2008). Effects of peer tutoring on young children's social interactions. *Early Child Development and Care, 178*(6), 617-635.

Yuan, C., Wang, L., Huo, Z., & Min, Q. (2024). Teaching cooperation to children with autism during play. *Journal of Developmental and Physical Disabilities*. https://doi.org/10.1007/s10882-023-09945-1

Zercher, C., Hunt, P., Schuler, A. & Webster, J. (2001). Increasing joint attention, play and language through peer supported play. *The National Autistic Society, 5*(4), 374-398.

Appendix A

VBDT Cusps Wheel



Note. This VBDT Cusps Wheel was taken from the ELCAR (Greer et al., 2023)