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Advancing Relational Vocabulary in AAC: Leveraging Joint-Action and Interaction for Language Learning

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Advancing Relational Vocabulary in AAC:

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by

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Abstract

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Relational vocabulary plays a foundational role in cognitive and linguistic development and in enabling autonomy, participation, and joint action. Despite its significance, relational vocabulary remains underrepresented in AAC research and practice, creating a critical gap in resources and intervention strategies. This dissertation foregrounds conversation, sensorimotor experience, and joint-action as pivotal mechanisms for teaching relational vocabulary to children who communicate with speech-generating devices (SGDs). By integrating theories of language acquisition and embodied cognition across three studies, this dissertation explores an AAC intervention paradigm that grounds language learning in action-driven, socially mediated contexts.

The dissertation includes three connected studies that collectively advance an action-based approach to AAC intervention, focused on relational vocabulary. The first study highlights the importance of relational vocabulary for AAC users and exposes gaps in current practices for vocabulary selection through an empirical analysis of available resources. In this study, I propose an additional approach for vocabulary selection in AAC that emphasizes direct engagement with relational concepts and language for directing actions. The second is a conceptual paper that examines conversational recasts and self-repair—two mechanisms of interaction that drive language acquisition—as pathways for aided language learning. It positions children as active agents in their linguistic development, advocating for explicit prompts to encourage SGD-mediated output and self-repair in conversation-based interventions. The third study is a design-based research project that moves this dissertation from theory to practice. This final paper introduces Building Relational Vocabulary Together (BRVT), a theoretically grounded instructional tool that situates relational vocabulary teaching and learning within collaborative joint-action. This study evaluates BRVT through semi-structured naturalistic intervention sessions with two students who communicate with SGDs. Collectively, these studies advance AAC intervention research, offering both theoretical contributions and practical innovations for teaching relational vocabulary through an action-oriented approach.

Dedication

This dissertation is dedicated to all the clients, students, and families I have had the privilege to work with throughout my career. You have been my greatest teachers. I am forever grateful for the lessons you've shared with me.

And to my family and friends, old and new, who have managed to push me through the finish line.

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1. Introduction

In the field of Communication Sciences and Disorders, Augmentative and Alternative Communication (AAC) is a relatively nascent subject in terms of both clinical practice and research (Zangari et al., 1994). However, the past few decades have seen remarkable advancements in communication aid technology (Vanderheiden, 2002) and clinical strategies for fostering language growth among children acquiring language through aided AAC (Beukelman & Light, 2020). *Aided AAC* is an umbrella term for communication systems that utilize external artifacts, like alphabet boards, pictures, or speech-generating technology. These systems are applied to diverse objectives and used by individuals with various conditions that affect spoken communication. The specific motivation behind this research program is to support expressive language development among children with motor speech impairments who communicate with speech-generating devices. S*peech generating devices* (SGDs) are an electronic form of AAC that augment or replace spoken speech with synthesized speech output based on the user's selections.

Figure 1

Examples of Speech-Generating Devices

Note: Examples of speech-generating devices. Reprinted from Augmentative-Alternative Communication and Assistive Technology Center The University of Akron, School of Speech-Language Pathology and Audiology, https://www.uakron.edu/sslpa/aac/. 2024 by The University of Akron. Reprinted with permission.

Despite encouraging progress, research and practice in AAC present two significant gaps that are addressed by this dissertation. First, there is a notable lack of scholarship and evidence-based practice concerned with relational vocabulary within the AAC field, despite its foundational role in academic success (Boehm, 2004; Bracken & Crawford, 2010; Estes et al., 1976), cognitive development, social interaction, and language development. *Relational vocabulary* refers to words that describe the relationship between people, objects, events, and situations in terms of location (e.g., far), dimension (e.g., longer), position (e.g., behind), movement (e.g., faster), quantity (e.g., few), presence (e.g., gone), and sequence (e.g., before; Boehm, 2004). They contribute to our ability to tell stories, recount past events, describe objects and situations, and share observations. Lack of access to relational vocabulary, then, can have significant implications on the types of communication functions that people using AAC can engage in. Notably, relational words enable individuals to direct the attention and actions of others (e.g., move *faster*; the one in the *back*). This ability is particularly valuable for individuals with involved motor impairments who use AAC, as it provides a means for guiding the actions of those who support them, promoting greater autonomy in managing their care and participation in activities (Cooper et al., 2022). Unfortunately, resources for teaching relational vocabulary to

this population are limited. This dissertation addresses this gap by underscoring the importance of relational language in AAC intervention and exploring solutions for facilitating their development.

The second contribution of this work is to advance a perspective that AAC interventions should emphasize direct sensorimotor experience by situating language teaching in action and interaction. A large body of AAC research on input-based strategies such as modeling language on AAC devices within contexts like storybook reading (O'Neill et al., 2018) have made valuable contributions to clinical practice. However, this dissertation echoes concerns about the passive role of the learner in input-oriented approaches as these methods may limit opportunities for children to practice language output or to connect graphic symbols with their social function and situated meaning. This dissertation adopts the view that language learning is an active process whereby symbolic meaning, including the meaning of graphic symbols, is constructed through interaction with the social and material environment, as individuals engage in situated activity (Borghi et al., 2013; Goodwin, 2018; Von Tetzchner et al., 2018; Vygotsky, 1962). This perspective is relevant for teaching relational vocabulary given their direct connection to sensory experience (e.g., *heavy*) and environmental conditions (e.g., *behind*). They are also highly salient in when giving directions, providing unknown information, and describing actions, making them a key semiotic resource for engaging in joint-activity.

Recently, intervention studies that encourage active message generation in naturalistic conversations have shown promise in advancing a more interactive approach to AAC learning (Soto & Clarke, 2017, 2018). This shift aligns with a broader sociocultural perspective in AAC, which views language learning as a socially mediated, multimodal process shaped by the social and material environment (Clarke et al., 2017; Smith, 2015). Despite this promising shift, many AAC interventions fail to fully incorporate sensorimotor experience and joint action as integral mechanisms for language learning. Drawing from theories of embodied cognition (Wilson, 2002), sociocultural learning (Vygotsky, 1962), and co-operative action (Goodwin, 2018) this dissertation advances an AAC paradigm that integrates embodied action and social interaction to support relational vocabulary learning for children using SGDs. The overarching goal is to explore how an action-based, interaction-focused approach can create effective learning conditions for relational vocabulary development.

The dissertation includes three connected studies that collectively advance an action-based approach to AAC intervention, focused on relational vocabulary:

Chapter 2 introduces relational vocabulary—a vocabulary class that enables joint action. In Chapter 2, I underscore the importance of relational vocabulary for children with complex communication needs and bring attention to the absence of relational vocabulary in academic dialogue regarding vocabulary selection for AAC. The study presents an examination into the presence of relational vocabulary on published word lists intended to guide vocabulary selection (known as *core word lists*). I present the shortcomings of existing approaches to vocabulary selection in AAC and demonstrate how the prevalent dichotomy of core (i.e., high-frequency) and fringe (i.e., personalized or context-dependent) vocabulary, undergirding vocabulary selection for clinical intervention, tends to undermine the importance of relational vocabulary words. To advocate for the inclusion of relational vocabulary in AAC intervention, this paper explicates the centrality of relational vocabulary for enabling joint action and participation in situated activities.

Chapter 3 examines the active role children play in language acquisition (Renner, 2002; Vygotsky, 1962) and foregrounds conversation as the bedrock of linguistic development

(Chouinard & Clark, 2003; Clark, 2018). It explores how interactions between adults and children create a context for mechanisms that facilitate language acquisition, with particular attention to adult reformulations of children's speech and children's self-repair. The chapter evaluates the potential of conversation-based interventions to support aided language learning, while critically addressing the interactional challenges inherent in AAC-mediated communication that may hinder the effectiveness of conversation-based approaches. Grounded in a social constructivist perspective, this chapter identifies conversational recasts and self-repair as pivotal mechanisms for providing feedback and fostering production practice in pragmatically rich contexts. A key contribution of Chapter 3 is the introduction of explicit prompts to self-repair utterances following recasts, a strategy that equips clinicians to more effectively use naturalistic conversations and joint activities as teaching opportunities. A unique contribution of Chapter 3 is the proposal to integrate explicit prompts for repairing utterances following recasts, enhancing the efficacy of conversation-based therapy. Chapter 3 contributes to an action-based approach to AAC by enabling clinicians to more effectively use naturalistic conversation and joint activity as contexts for teaching.

Chapter 4 transitions from theory to practice through a design-based research project. It introduces Building Relational Vocabulary Together (BRVT), a novel instructional tool designed to support relational vocabulary use in children using speech-generating devices (SGDs). Grounded in sociocultural, constructivist, and embodiment theories, BRVT incorporates embodied design principles (Abrahamson, 2014; Tancredi et al., 2022) to create an intervention activity that facilitates relational vocabulary learning through collaborative joint-action. This chapter examines the feasibility of BRVT as a tool for teaching relational vocabulary by analyzing how its barrier-game format and specially designed artifacts promote key interactional processes. These include establishing mutual understanding, integrating sensory and linguistic experiences, and supporting self-repair. Understanding how to best elicit these processes can inform clinical approaches that leverage meaningful, child-directed activity as a context for teaching vocabulary. Analyzing data from semi-structured sessions involving BRVT, Chapter 4 demonstrates how an intervention grounded in action and interaction can create rich conditions for teaching and learning relational vocabulary on SGDs.

Together, these studies contribute to an AAC intervention paradigm that foregrounds action, interaction, and sensorimotor experience as core components of language learning. By addressing relational vocabulary within this framework, this dissertation not only fills a practical gap in AAC research but also advances the theoretical foundations underlying AAC-mediated intervention. The approach put forward by this dissertation frames aided language as a means for *doing*, making joint-action and situated interaction central to intervention and teaching.

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2. The Prevalence of Relational Basic Concepts on Core Vocabulary Lists for AAC: Is Frequency Enough?

Cooper, B., & Soto, G. (2024). The prevalence of relational basic concepts on core vocabulary lists for AAC: Is frequency enough? *Augmentative and Alternative Communication.* https://doi.org/10.1080/07434618.2024.2332648

Relational vocabulary, also referred to as Relational Basic Concepts (RBCs), represent the focal domain of this dissertation for both theoretical and practical reasons. From a theoretical perspective, RBCs emerge as an interesting case study when adopting a social constructivist and embodied perspective of language development. First, it is generally accepted that sensorimotor experience during infancy drives the development of early emerging relational concept such as containment, existence, and movement (Bloom, 1973). Secondly, RBCs allow speakers to verbalize their first-hand perceptual experiences, either current or anticipated, based on prior, current, or future sensorimotor activity (e.g., "I saw it *under* the bed"; "this one looks *darker* to me") as well as the projected perceptual experiences of others (e.g., "it will be on *your left*"). They also permit individuals to narrate or describe motor actions relative to other relevant possibilities (e.g., "I'm moving them *farther apart"*) and direct the attention of collaborative others to specified features relative to other features within joint attention (e.g., "the *skinny* one"). Perhaps the most overt connection is that relational words are ubiquitous in directive language, such as "*open* the window" or "move *faster*," making them key semiotic resources for engaging in joint-activity.

The focus on relational vocabulary also has practical significance for AAC-based intervention, where selection of appropriate vocabulary is a crucial and challenging aspect. RBCs describe relationships between objects, persons, or situations, and play a pivotal role in language development, communication, and academic success; however, there is very little literature in the field of AAC concerned with relational language. Prior to the publication of this chapter, there were no published vocabulary selection resources specifically dedicated to selecting appropriate RBCs. The study presented in Chapter 2 resulted in a novel vocabulary selection resource for clinicians making vocabulary decisions for their students and clients. For the present study, we created a list of 156 RBCs, drawing primarily from assessments that measure basic concept knowledge in preschool and early elementary school students. We examined the overlap of these words on nine core vocabulary lists. Core vocabulary lists are frequently used to support vocabulary selection for children who require AAC. We found that most concepts were not represented on any core lists. Additionally, there was relatively little overlap of RBCs between the core lists. These findings suggest that vocabulary selection resources created using exclusively a core vocabulary approach may have limited utility for identifying many concepts that preschool and early elementary students are expected to know and use.

This chapter considers the shortcomings of existing approaches to vocabulary selection in AAC, namely an emphasis on high-frequency (i.e., core) and context-dependent (i.e., fringe) vocabulary that omits many RBCs. The implications of Chapter 2 encourage practitioners to recognize RBCs as critically important for linguistic participation in situated social activities and to consider opportunities for joint-action as focal contexts for identifying, teaching, and practicing relational vocabulary with students.

2.1 Introduction

Augmentative and alternative communication (AAC) intervention can promote communication and language skills in children who have little or no functional speech (Langarika-Rocafort et al., 2021). One critical and challenging aspect of AAC intervention is vocabulary selection, especially for preliterate children, who cannot yet fully rely on the alphabet. Determining appropriate and adequate vocabulary is always an individualized process; however, the need to convey essential messages and the eventual development of language skills have become two established principles for guiding AAC vocabulary selection decisions (Beukelman & Light, 2020; van Tilborg & Deckers, 2016). To meet these objectives, ample literature has called for a two-pronged vocabulary selection approach that includes personalized and context-dependent vocabulary often referred to as fringe vocabulary, along with high-frequency core words (Beukelman & Light, 2020; Dodd & Gorey, 2014; Fallon et al., 2001).

Fringe vocabularies are predominantly composed of words with concrete referents, such as people, places, objects, or actions that relate to an individual's preferences, interests, and needs, or to particular tasks, environments, and routines. Fringe words are an important component of personalized AAC intervention (Light et al., 2021). Core vocabulary is commonly defined as a relatively small set of words that are used across individuals, contexts, topics, and settings (van Tilborg & Deckers, 2016). Core words are considered beneficial for promoting aided language development because they can be used in a variety of situations, promote word combinations, and can be presented in a consistent location on communication displays. Numerous studies have analyzed language samples of typically developing children within a focal age-range to uncover common and/or high-frequency words that can guide vocabulary selection for children developing aided language (Banajee et al., 2003; Beukelman et al., 1989; Boenisch & Soto, 2015; Marvin et al., 1994; Trembath et al., 2007).

Core words are an important element of vocabulary for aided communicators; however, there is agreement that a narrow focus on expressive word frequency might overshadow personal, contextual, and conceptual words that are important for linguistic and cognitive development (Bean et al., 2019; Beukelman & Light, 2020; McCarthy et al., 2017; Quick et al., 2019), especially for children at the early stages of language acquisition for whom many core words may not be developmentally appropriate (Frick Semmler et al., 2023; Laubscher & Light, 2020). Although core vocabulary is popular among researchers and practitioners (e.g., Center for Literacy and Disability Studies, 2020; Judge et al., 2023; van Tilborg & Deckers, 2016), many acknowledge that AAC systems limited to core words are insufficient to meet the communication needs of individuals (e.g., Cooper et al., 2022; Fallon et al., 2001; Frick Semmler et al., 2023; Laubscher & Light, 2020). Best practice for AAC intervention routinely states that systems should be include both core and fringe vocabulary and there are widely available tools to support the identification of both word types (e.g., Beukelman & Light, 2020; Cooper et al., 2022; Fallon et al., 2001; Light et al., 2021; Soto, 2009).

Attention to core and fringe words will yield important vocabulary, however, many words that children who use AAC need may still be left out. An important vocabulary domain associated with relatively less research and fewer resources compared to core and fringe vocabulary is relational basic concepts (RBCs). RBCs are domain-general words that describe relationships between objects, persons, or situations in terms of space, size, quantity, and time (Boehm, 2004). Decades of research involving typically developing children has shown that RBCs are important for language and cognitive development as well as school success (Boehm, 2013; Chan et al., 2022; Gallivan, 1988; Gopnik, 1988; Steinbauer & Heller, 1978). A small but growing body of literature has brought attention to the importance of basic concepts when

selecting vocabulary for children who use AAC (Bean et al., 2019; Cooper et al., 2022; McCarthy et al., 2017; Soto & Tönsing, 2023); yet the dichotomy of 'core' and 'fringe' appears to be a prevailing paradigm in research and practice (e.g., Frick Semmler et al., 2023; Judge et al., 2023)

Without special consideration of RBCs, there is a potential risk of neglecting important conceptual words that are not considered personally significant to an individual, tied to a specific context, or among the most frequently spoken words by children within a specified age range. Given the prevailing focus on core and fringe vocabulary and the widespread use of core lists in clinical practice (Judge et al., 2023), a closer examination into the presence of RBCs on core lists intended to serve vocabulary selection for AAC is warranted.

2.1.1 Relational Basic Concepts

Relational basic concepts (RBCs) are words that describe relationships between people, objects, events, and situations. They refer to position in space (e.g., *under*), movement (e.g., *away*), presence (e.g., *gone*), size (e.g., *small*), dimension (e.g., *thick*), quantity (e.g., *many*), and time (e.g., *before*; Boehm, 2004). RBCs are a subset of a larger category of words known as *basic concepts*. Basic concepts include a range of early developing concepts, such as letters, numbers, shapes, relational nouns (e.g., *brother*), materials (e.g., *glass*), states (e.g., *hungry*) and adjectives (e.g., *pretty*; Bracken & Crawford, 2010). RBC are unique from basic concepts, which have a stable definition across situations, because their meaning or referent changes based on context and arises from a relational judgment between objects, persons, situations, or in reference to a standard (Boehm, 2004; McCarthy et al., 2017). For example, something may be *first* from one direction but *last* from another. In addition, comprehension of a relational word in one domain may not ensure comprehension in another (e.g., *first* can refer to a spatial position and a temporal order).

The acquisition of relational vocabulary is a developmental process (Bracken, 1988; de Villiers & de Villiers, 1978; Walker, 1979). During the single word stage when children have fewer than 50 words, RBCs, such as those referring to recurrence (e.g., *more*), movement (e.g., *up*), and disappearance (e.g., *gone, alldone*), make up a significant portion of children's expressive vocabulary (Bloom, 1973; Gopnik, 1988). By the time children enter preschool, they are expected to use numerous relational words and comprehend many more (Bracken & Crawford, 2010). Bracken & Crawford (2009) reviewed early childhood education standards in all 50 United States and found that knowledge and skills related to basic concepts, including RBCs, were incorporated into every state's curriculum standards. Several RBCs, such as size (e.g., large/small) and time (e.g., before, after), are explicitly stated in curriculum standards while others are reflected indirectly through skills such as describing, identifying similarities and differences, and forming analogies (Dumas et al., 2013).

Among typically developing children, knowledge, exposure, and use of RBCs has been found to correlate with a number of academic and cognitive skills including overall vocabulary and language development (Steinbauer & Heller, 1978), early math and reading achievement (Busch, 1980; Estes et al., 1976; Gallivan, 1988; Piersel & McAndrews, 1982), numeracy skills (Chan et al., 2022), mental reorientation (Hermer-Vazquez et al., 2001), and analogies (Christie & Gentner, 2014; Silvey et al., 2017). Furthermore, assessments and screeners that include RBCs, such as the Wiig Assessment of Basic Concepts (WABC; Wiig, 2004), the Bracken Basic Concept Scale-Revised (BBCS-R; Bracken, 1998) and the Boehm Test of Basic Concepts-3rd Edition (BTBC-3; (Boehm, 2001), are strongly correlated with school readiness and later

academic achievement (Panter, 2000; Panter & Bracken, 2009). For example, Gallivan (1988) found that first grade scores on the BTBC predicted vocabulary and reading performance in 4th grade, suggesting that lasting reading challenges may be related to poor conceptual knowledge typically mastered by age six (Boehm, 2001).

Familiarity with RBCs at a young age likely contributes to academic achievement, in part, because of their frequent use by early education teachers (Boehm, 2004; McCarthy et al., 2012, as cited by McCarthy et al., 2017). Boehm et al. (1986; as cited in Boehm, 2004), analyzed teachers' talk for the use of RBCs from the BTBC. In a single hour of recorded instruction, six pre-kindergarten teachers produced 47 of the 50 BTBC items along with 10 synonyms. RBCs provide children with the language and comprehension needed to understand and give directions, ask and answer questions, discuss content, and benefit from instruction (Bracken & Crawford, 2010). Despite their significance, many conceptual words including relational concepts are not included on widely used AAC language systems (McCarthy et al., 2017). Neglect of RBCs within the field of AAC raises questions about how their absence may influence communication, participation, and academic outcomes for children developing aided communication.

2.1.2 Relational Language in Aided Communicators

Information about RBC development or about the relationship between RBCs and academic outcomes for children with complex communication needs (CCN) who use AAC is very limited. Formal assessments of language and intellectual functioning are often not conducted for children with CCN because standardized assessments are perceived as challenging (Kurmanaviciute & Stadskleiv, 2017). When formal assessments are used, comprehension of vocabulary concerning temporal, spatial, and movement concepts may be particularly difficult to assess given the frequent use of static images to represent concepts (Moseley et al., 2021). Furthermore, few studies have explicitly explored the topic of RBCs relative to children who use AAC (Erwin-Davidson, 2019; McCarthy et al., 2017; Moseley et al., 2021).

Some insights regarding the use of RBCs by children with CCN who use AAC have come from studies conducted as part of an international project called Becoming an Aided Communicator (BAC; Von Tetzchner, 2018). Although none of the studies inquire about relational words specifically, there is some evidence suggesting that aided communicators comprehend graphic symbols representing nouns and verbs more easily than those representing prepositions and locatives; and that aided communicators provide relatively few descriptions of perceptual features (e.g., big, round, small, short) to describe objects (Deliberato et al., 2018). Other studies (Batorowicz et al., 2016; Stadskleiv et al., 2018) sought to understand how aided communicators provide instructions to communication partners to carry out actions using the *BAC Construction* task. In that task, participants described a physical model (e.g., a dressed doll, beads on a string) so that their partner could construct an identical one without seeing the original. The findings from Batorowicz et al. (2016) show that nearly a quarter of the errors made by the aided communicators involved orientation and sequence and another 15% of errors related to size. Compared to a reference group of age-matched typically developing children, Stadskleiv et al. (2018) found that aided communicators used fewer words to describe attributes overall (i.e., size, shape, placement, number, color); but, noted similarities between the groups regarding the frequency of word categories used. Both the aided communicators and the reference group used color words most frequently and shape words least frequently. However, the use of visual-spatial vocabulary (i.e., location, sequence, direction) represented a notable difference, as this category was the second most frequently used category by the naturally

speaking children, while representing the least common category for the aided group aside from shape words. In addition, errors related to visual-spatial vocabulary were the most common error type made by the aided group besides missing elements in the final construction.

There are several factors that potentially contribute to the relative difficulty that aided communicators present with relational vocabulary compared to other word types. Investigators have found a high incidence of visual-perceptual impairment among children with motor disabilities (Ego et al., 2015) and a tendency to demonstrate poor visual-spatial skills such as large-scale spatial awareness (Foreman et al., 1989; Wiedenbauer & Jansen-Osmann, 2006), mental rotation (Farran et al., 2021), visual-spatial perception (Critten et al., 2018; Stadskleiv et al., 2018) and visual-spatial memory (Critten et al., 2018).

A large body of literature has established a relationship between elements of motor development and visual-spatial skills in children (Anderson et al., 2013; Campos et al., 2000; Cortes et al., 2022), including a connection between independent exploration in infancy and the use of spatial language in later childhood (Oudgenoeg-Paz et al., 2016). Therefore, limitations in exploration, object manipulation, and locomotion in early childhood are thought to negatively impact the development of visual-spatial abilities and spatial language for children with physical impairments (Batorowicz et al., 2016; Farran et al., 2021; Light, 1997; Stadskleiv et al., 2018).

Another reason why children with CCN who use AAC may struggle to learn and use relational vocabulary may be due to their limited experience with activities that engender relational language (Batorowicz et al., 2016; Light, 1997; Murray et al., 2018; Stadskleiv et al., 2018; Von Tetzchner, 2018). For instance, construction play, such as building with blocks or assembling pieces is associated with spatial ability (Casey et al., 2008; Zhang et al., 2020) and comprehension of spatial relational words (Marcinowski & Campbell, 2017). Adults also tend to use more spatial language when engaging in construction tasks with children compared to other types of play (Ferrara et al., 2011), which has consequences for the amount of spatial language children produce (Pruden et al., 2011; Pruden & Levine, 2017). Children who use AAC may also have limited opportunities to communicate information that is unknown to their communication partner or have practice providing instructions for action (Light, 1997; Murray et al., 2018; Stadskleiv et al., 2018; Von Tetzchner, 2018), both of which are communication situations that elicit relational language.

Children who use AAC rely on others to provide and teach vocabulary. Considering the association between RBCs, educational outcomes, and communication, opportunities to learn and use these concepts should be an important part of intervention using AAC. Unfortunately, there is an absence of vocabulary selection resources dedicated to RBCs. Furthermore, it is unclear whether established vocabulary selection resources, such as core vocabulary lists, are adequate for supporting the identification of RBCs for school-aged children who use AAC. To address these gaps, the current study investigates the presence of RBCs on core word lists that are intended to guide vocabulary selection for school-aged children who use AAC.

2.2 Methods

2.2.1 Core Vocabulary List Inclusion Criteria

Core vocabulary lists were included in this study if they met the following criteria: (a) were published in a peer-reviewed journal, (b) included vocabulary lists developed for the purpose of informing vocabulary selection for children who require AAC aged 7 or younger, (c)

were developed by sampling the spoken or written production of English speakers; and (d) produced English word lists. Studies that included non-monolingual-English speakers were included in the present study if the data collected included English language samples exclusively. Words lists resulting from secondary analyses of published lists or inventories were not included (e.g., Fallon et al., 2001; Laubscher & Light, 2020; Soto & Cooper, 2021).

2.2.2 Search Methods

Six databases [PsychInfo, Educational Resources Information Center (ERIC), Linguistics and Language Behavior Abstracts (LLBA), JSTOR, PubMed, GoogleScholar) were searched using the following search terms: (a) core vocabulary ("core vocabulary" OR "core words") and (b) AAC (AAC OR "Augmentative and Alternative Communication"). Nine studies met the inclusion criteria (Banajee et al., 2003; Beukelman et al., 1989; Clendon et al., 2013; Crestani et al., 2010; Fried-Oken & More, 1992; Marvin et al., 1994; Sanders & Blakeley, 2021; Trembath et al., 2007; Wood et al., 2016). Information about the participants, language sampling context, length, and organization of each core word list is summarized in Table 1.

Table 1

Demographics, Data Collection Summary, and Description of Core Vocabulary List Across Studies

Study	Participants			Data collection		Core word list		
	N	Age*	Profile	Source	Context (location; activities)	Operational definition	# of words	Organization
Banajee et al. (2003)	50	2;0 - 3; 0	TD	LS	School or daycare; play and snack	Words used across 6, 5, or 4 different days or activities	23	Divided by commonality score then high frequency to low frequency
Beukelman et al. (1989)	6	3;8 - 4;9	TD	LS	Preschool, not specified	Words occurring with a frequency of at least .5 in 1000	250	High frequency to low frequency
Clendon et al. (2013)	124	Grade K-1	TD	WS	School writing workshop; writing of self-selected topics	140 most frequently occurring words	140	High frequency to low frequency
Crestani et al. (2010)	28	5;0-7;2	TD	LS	Not specified; story retelling task	50 most frequently occurring words	50	High frequency to low frequency
Fried-Oken and More (1992)	45[a]	3;0 - 6;3	TD, AAC	LS, IR	Not specified, play	Top 10% of words appearing on at least 3 of 90 source lists	211	Highest to lowest commonality score
Marvin et al. (1994)	10	4;0 - 5;2	TD	LS	Home and preschool; routine activities	Words occurring with a frequency of at least .5 in 1000	332	Divided as function words or content words then alphabetized
Sanders & Blakeley (2021)	16	5;0-5;11	TD	LS	University; dialogic book reading	Words used by at least 10 of the 16 participants	84[b]	Divided by book then highest to lowest commonality score

Trembath et al. (2007)	6	3;0 5;0	TD	LS	Preschool; routine activities	Words occurring with a frequency of at least .5 in 1000 and used by at least 50% of participants	263	High frequency to low frequency
Wood et al. (2016)	94 [c]	Grade 1	TD	WS	Not specified; writing based on prompt	50 most frequently occurring words	50	Divided by grade then high frequency to low frequency

Note. TD = typical development; AAC = children who use augmentative and alternative communication; LS = language sample; WS = writing sample; IR = informant report.

[a] 30 typically developing children and 15 children with cerebral palsy. [b] Identified 59 core words for each book. 34 core words were shared and 50 were unique. [c] Data from 94 students in 1st grade is used in present study. Data from 117 4th grade students are not included in the present study.

* years; months

2.2.3 Procedures to Create the Relational Basic Concept List

To analyze the representation of RBCs in the core vocabulary lists, a RBC list was generated. The RBC list was created by extracting relational vocabulary included in a larger basic concept database produced by Schwarz and McCarthy (2012), which includes both relational (e.g., *far, different, most*) and non-relational concepts (e.g., *yellow, five, tired, winter, penny*). The Schwarz and McCarthy database includes all the words on three widely used assessments for measuring school readiness of preschool and early elementary students: the Wiig Assessment of Basic Concepts (WABC; Wiig, 2004; normed for children aged 2;6 to 7;11), the Boehm Test of Basic Concepts-3rd Edition (Boehm-3; Boehm, 2001; normed for children Grades K-2), and the Bracken Basic Concept Scale-Revised (BBCS-R; Bracken, 1998; normed for children aged 2;6 to 7;11). It includes 334 words divided into eleven categories based on the organization of the BBCS-R (Bracken, 1998; see McCarthy et al., 2017 for the procedures used to create the basic concept database). The Schwarz and McCarthy (2012) basic concept database is available at <https://www.uthsc.edu/asp/research/documents/l3-basic-concept-vocabulary-database.pdf >.

Words from the Schwarz and McCarthy (2012) basic concept vocabulary lists were included in the RBC list if they met the following criteria: (a) described relationships or comparisons between people, objects, occurrences, places, events, or situations (b) changed in referential meaning depending on context, (c) did not refer to attributes of single entities, events, or situations (e.g., *smooth* can describe the surface of a table without comparing it to other surfaces); and (d) were not nouns, verbs, pronouns, or grammatical function words (e.g., than). Each author identified RBCs from the Schwarz and McCarthy database, discussed discrepancies, and reached consensuses for all the discrepancies.

To prevent duplicate entries, five superlative words listed in the original basic concept database (i.e., *farthest, fewest, earliest, newest, slowest*) were not included because their root word (i.e., *far, few, early, new, slow*) were included. Because the core vocabulary lists provide single words, multi-word entries in the Schwarz and McCarthy database were omitted or consolidated with synonymous words. The items “not the same” and “some, not many” were omitted; however, “same,” “some,” and “many” were included. “Next to” and “in front” were considered synonymous with existing items “beside” and “front,” respectively. “Medium-sized” and “a lot” were included but shortened to “medium” and “lot.” These procedures resulted in a total of 147 RBCs.

2.2.4 Data Analysis: Overlap between the RBC List with the Core Vocabulary Lists

Using Microsoft Excel for Mac, the first author reviewed each of the core vocabulary lists to examine the presence of RBC vocabulary. Each word from the nine core vocabulary lists was associated with a binary coding (1 for success, 0 for failure) to describe whether the word was found on the RBC list (Quick et al., 2019). While reviewing the core lists, ten additional words that were not in the Schwarz and McCarthy (2012) database met the definition for RBCs stated in the previous section and were incorporated into the RBC. Nine words were added as new items: *again, best, bit, better, else, even, gone, like, not*). A tenth word, *done*, was incorporated as a synonym for *finished.* These additions resulted in a final list of 156 RBCs

(Section 2.8; the ten words from core vocabulary lists are marked with an asterisk). After totaling the number of successes on each core vocabulary list, the proportion of RBCs was calculated by dividing the number of successes by the total number of core words. In addition, the number of successes was divided by 156 to determine the percentage of the RBC list captured by each core word list.

2.3 Results

To examine the presence of RBCs on the core vocabulary lists, each list was compared to the final RBC list (n=156). The results of the analysis are summarized in Table 2.

Table 2

Summary of Overlap Between RBC List and Core Vocabulary Lists

Study	Total words	Overlapping words	% Core list	% RBC Database
Banajee et al. (2003)	23	8	34.8%	5.1%
Beukelman et al. (1989)	250	38	15.2%	24.4%
Clendon et al. (2013)	140	23	16.4%	14.7%
Crestani et al. (2010)	50	8	16.0%	5.1%
Fried-Oken and More (1992)	211	31	14.7%	19.9%
Marvin et al. (1994)	332	58	17.5%	37.2%
Sanders and Blakeley (2021)	84	14	16.7%	9.0%
Trembath et al. (2007)	263	37	14.1%	23.7%
Wood et al. (2016)	50	6	12.0%	3.8%

RBCs were present on all nine lists, regardless of participant age, sampling context, or inclusion criteria. This confirms that there is some overlap between RBCs and high-frequency core words. The number of RBCs included on the lists ranged from six (Wood et al., 2016) to 58 (Marvin et al., 1994), with the average being 24 RBCs. The 58 RBCs captured by Marvin et al. (1994) represent 37% of the RBC list (i.e., 58 out of 156 RBCs). Wood et al. (2016) represents less than 4% of the RBC list.

For each core vocabulary list, we calculated the proportion of core words that were RBCs. On average, RBCs made up approximately 17% of core vocabulary lists. Wood et al. (2016)'s list of 50 core words was composed of the smallest proportion of RBCs (12%; 6 of 50). The 23-item list published by Banajee et al. (2013) had the largest proportion of RBCs (35%).

To assess commonality, each relational word in the database was given a commonality score based on the number of core vocabulary lists where it was included (0-9). The list of RBCs appearing on one or more lists and the corresponding commonality score is available as Supplemental Materials. The commonality analysis revealed that 67 out of 156 RBCs appeared on at least one core vocabulary list. Of these, 47 were included on two or more, whereas 20 words appeared on only one core vocabulary list. Only two words, *in* and *on*, were included on

every core list we analyzed. All the words on the Banajee et al. (2003) list had a commonality score of at least 5. Eighty-nine RBCs (57%) did not appear on any list.

2.4 Discussion

The purpose of this paper was to examine the presence of relational basic concepts on core vocabulary lists that are commonly used as vocabulary selection resources for children who use AAC. The results revealed that there is some overlap between core words and RBCs; however, there was relatively little overlap of RBCs across the core lists. Only 2 RBCs (*in* and *on*) were present on all nine of the core vocabulary lists. Twenty RBCs were captured on only one core vocabulary list. More than half of the RBCs included on popular assessments for children in early grades were not captured by any core vocabulary list included in this study. For instance, *tall, short, empty, full, fast, slow, start, end, behind,* and *front* are just a few RBCs that were not captured by any of the core lists we analyzed.

A concerning finding from this study is that the majority of early emerging RBCs considered "core vocabulary" for toddlers 24 to 36 months old according to Banajee et al. (2003) are absent from one or more of other core lists. This warrants attention because words for early emerging RBCs are foundational to children's vocabulary and remain necessary throughout a person's life even if their frequency drops relative to other words in an expanding vocabulary. To illustrate, *here, more, done, some, off,* and *out* are considered core words for toddlers however, *here, more,* and *done* are not included on 4 lists (i.e., Clendon et al., 2013; Crestani et al., 2013; Sanders & Blakeley, 2021; Wood et al., 2016); *some* and *off* are not on three (i.e., Clendon et al., 2013; Crestani et al., 2013; Wood et al., 2016); and *out* is not listed on one (i.e., Sanders & Blakeley, 2021). While acknowledging that the core lists included in this study are relatively short, our findings point a need to consider factors other than frequency and commonality when judging a word's importance for AAC. For instance, Clendon et al. (2013), Crestani et al. (2013), and Wood et al. (2016) did not find *off* to be highly frequent in the speech of five- to seven-year-old children based on the operational definitions of core employed in their studies. However, dismissing 'off' as unimportant for a child in this age range simply because of its frequency may be misguided (e.g., prepositions like 'off' and 'out' are essential to the creation of prepositional phrases). While frequency analyses provide a method for selecting key vocabulary, we maintain that it should not be the only consideration.

It is possible that sampling context, such written language (i.e., Clendon et al., 2013; Wood et al., 2016), spoken language based on reading activities (i.e., Crestani et al., 2013; Sanders & Blakeley, 2021), spoken language during play and everyday routines (i.e., Banajee et al., 2003; Beukelman et al., 1989; Fried-Oken & More, 1992; Marvin et al., 1994; Trembath et al., 2007), or words provided by informants (i.e., Fried-Oken & More, 1992), influenced the inclusion of RBCs. The studies also differed in their approach towards defining and identifying core words for their lists. Some included the most frequently occurring words up to a predefined number, such as top 50 (i.e., Crestani et al., 2013; Wood et al., 2016) or top 140 (i.e., Clendon et al., 2013). Three studies (i.e., Beukelman et al., 1989; Marvin et al., 1994; Trembath et al., 2007) included all words occurring with a frequency of at least .5 in 1000 regardless of how many words met that criterion. Other studies used a commonality approach to identifying core words, such as words used across activities (Banajee et al., 2003), participants (i.e., Sanders & Blakeley, 2021; Trembath et al., 2007), or different sources (i.e., Fried-Oken & More, 1992). The studies by Trembath et al. (2007) and Fried-Oken and More (1992) used both frequency and commonality to generate their core word lists.

The number of words on each core vocabulary list, which is related to the operational definition of core words used by the study authors, seems related to the number of RBCs it includes. Lists that use a broader criterion for inclusion of core words, such as all words with a frequency of at least .5 in a thousand, generally incorporated a larger number of RBCs (e.g., Beukelman et al., 1989; Marvin et al., 1994; Trembath et al., 2007). Core vocabulary lists with a more stringent criteria like top 50 most frequently occurring words in the corpus contained fewer RBCs (e.g., Crestani et al., 2010; Wood et al., 2016). This pattern is reflected by the finding that Marvin et al.'s (1994) list is the longest included in the study (n=332) and also contains the largest number of RBCs, albeit less than 40% of all the RBCs we looked for. On the other hand, the lists by Crestani et al. (2010) and Wood et al. (2016) contain the 50 most frequent words in their respective samples and capture eight and six core words, respectively. Banajee et al. (2013) is the only exception to this pattern. Although the Banajee list only captures eight RBC words (i.e., *all done/finished, here, in, more, off, on, out, some*), these items make up almost 35% of the 23-item list; this is the largest representation of RBCs on any of the core vocabulary lists in terms of proportion despite being the shortest core list overall.

The age and syntactic level of the children sampled may have contributed to the findings as well. Banajee et al. (2013) sampled toddlers who reportedly communicated with 2-3-word utterances. The remaining core vocabulary lists all sampled children older than age 3 with Crestani et al. (2010) and Wood et al. (2016) including children as old as 7 or Grade 1. The present finding that the Banajee et al. (2003) list comprising the greatest proportion of RBCs is consistent with child language research showing that toddlers use a variety of conceptual-relational words, social words, nouns, and verbs (Bloom, 1973; Gopnik, 1988). In contrast, function words supporting grammaticalization emerge later in development (Brown, 1973; Frick Semmler et al., 2023). As lexical diversity and grammaticalization increase with age, function words are more likely to rank highest in terms of frequency (Bates et al., 1994), which contributes to the high representation of function words on core vocabulary lists developed from language samples of preschool and school-aged children (Frick Semmler et al., 2023).

Participant age, language sampling context, and the operational definition of a core word used by the study authors likely influenced the inclusion of RBCs. Given the procedural variability across the studies, determining the optimal method for incorporating RBCs within a core word approach is inconclusive. Although some overlap exists, he results strongly suggest that core word lists are not well suited for identifying most of the RBCs that children in early grades are expected to know and use. Many more RBCs are needed to support language acquisition; therefore, RBCs must be considered in addition to high-frequency core words.

2.4.1 Practical Implications

The inclusion of RBCs into AAC intervention and instruction may have implications at the earliest stages of language development. A main premise behind identifying high-frequency core words for inclusion on AAC systems is to facilitate the production of multiword combinations, such as "I see" and "it go" (Bean et al., 2019; van Tilborg & Deckers, 2016). Teaching multi word utterances is pivotal for language development because they serve as the foundation for grammaticalization (Hadley, 2006). Typically developing children tend to produce word combinations once they have a productive vocabulary of at least 50 words including nouns, verbs, and descriptive words. Vocabulary selection for AAC, then, should include a range of RBCs to support children's expanding vocabulary base. Moreover, RBCs make ideal candidates for word combinations, as they can be combined with core words (e.g.,

put down), fringe words (e.g., *Mickey first*), verbs (e.g., *throw far*), and other RBCs (e.g., *almost done*).

Although the overlap between the core lists and the RBC list is limited, it warrants noting that several RBCs are highly frequent in the speech of young children. For instance, *in, on, out, there,* and *up,* were identified as core words by at least seven of the core lists we reviewed (see Supplemental Materials). Because selecting vocabulary often involves competing priorities and constraints, RBCs that emerge relatively early in development and are frequently occurring may be an appropriate starting point for incorporating RBCs. Nonetheless, this study underscores the need to consider relatively less frequent RBCs that may also support linguistic, academic, and cognitive development.

The incorporation of RBCs into AAC intervention and instruction may also have significant implications for supporting action and autonomy, particularly for children with physical disabilities. For aided communicators who struggle to carry out their desired actions or explore the world independently due to severe physical impairment, the ability to use RBCs may hold even greater value than for children without motor limitations. RBCs play a critical role in directive language, which may offer aided communicators a means to engage with the world by instructing others to carry out their goals (Batorowicz et al., 2016). Unfortunately, many children with CCN have limited experience with giving directions to others (Batorowicz et al., 2016; Stadskleiv et al., 2018; Von Tetzchner, 2018).

Our findings align with prior work that has highlighted the drawback of adopting a singularly core approach to vocabulary selection in AAC (e.g., Laubscher & Light, 2020; Frick Semmler et al., 2023). A relatively novel implication underscored by this research is a need to go beyond the conventional approach of balancing core and fringe words when striving to provide children with a robust vocabulary. Although the present study is focused on the utility of core lists for identifying RBC vocabulary, it stands to reason that RBCs are unlikely to represent an individual's fringe vocabulary, which should reflect their identity, personal needs, and interests.

Regardless of the type of vocabulary (i.e., core, fringe, RBCs), vocabulary selection is always an individualized process of identifying words that are most beneficial to a particular child. To facilitate the selection of appropriate RBCs, a cognitive approach is one framework that has been suggested. A cognitive approach focuses on the vocabulary an individual needs to comprehend, participate in, and discuss reasoning tasks like comparing, describing, evaluating, measuring, and categorizing (Cooper et al., 2022). When applied to these activities, established vocabulary selection strategies such as task analyses, observations, and communication diaries may be successful for noting valuable RBCs. To illustrate, when considering words that support participation in a lesson on currency and change, exercising a cognitive approach may elevate RBCs that support comparison such as *equal, almost,* and *enough.* Academic materials, curriculum standards, and assessments can provide an additional avenue for selecting RBC vocabulary. For example, foundational literacy standards for kindergarten students are to follow words from top to bottom; isolate initial, medial, and final sounds; and distinguish between same and different letters across words (National Governors Association Center for Best Practices and Council of Chief State School Officers, 2010). For some children with language disabilities, explicit instruction and practice with concepts that underly these standards (i.e., top, bottom, first, middle, last, same, different) may contribute to academic participation and progress. Finally, several BAC researchers (see Von Tetzchner, 2018 for introduction to BAC special issue) have pointed out the need to support aided communicators in using directive language as a potential means of compensating for limited mobility. Providing or examining opportunities to

give instructions, such as incorporating barrier-games, may also shine light on useful RBC vocabulary.

Although RBCs are a critical component of children's vocabularies, RBCs alone are insufficient to meet a child's communication needs. A robust vocabulary for school-aged children using AAC must include a variety of core, personal, and task/environment-dependent vocabulary in addition to relational and non-relational basic concepts. To capture a broad scope of words, clinicians should draw upon multiple vocabulary selection approaches, strategies, and resources (Cooper et al. 2022).

2.5 Limitations and Future Directions

The present study has important implications for clinical practice; however, the outcomes must be considered in light of the study's limitations. Our analysis includes a relatively wide scope of core vocabulary lists in terms of participant age, sampling context, and analysis procedures. While our broad inclusion criteria may have contributed to this initial investigation of RBCs on core lists, it potentially constrained our ability to pinpoint effective procedures for capturing RBCs when using a core approach. Future research can explore ways identify RBCs that are frequent in children's speech. Another limitation of the present study is that we only include core vocabulary lists and words from RBC assessments published in English. Core vocabulary lists are language specific with relatively little overlap across languages (Soto & Tönsing, 2023). In addition, relational vocabulary refers to conceptual categories that may not be represented across all languages (see Bowerman & Choi, 2001 for a discussion about language specific spatial categories). Future research should investigate the presence of relational vocabulary on core lists developed for languages besides English as well as compare RBCs used by children learning different languages.

The final RBC list provided in Section 2.8 has limitations that need to be considered. The RBC list was created by reviewing a database of all the words included on three assessments of basic concepts for children aged 7 and below, which were not intended to be used as vocabulary selection tools. One ramification of using assessments is that they may not include some early developing concepts. As described in the method section, we identified 10 words from the core vocabulary lists that met the definition for RBCs that were not included on the assessments (i.e., *again, best, bit, better, done, else, even, gone, like, not*). Although we added these words to the final RBC list, it should not be considered an exhaustive list of all relational concepts. Future research should aim to generate other resources and strategies for identifying developmentally appropriate RBCs that may not be captured on our RBC list.

The RBC list and the original Shwartz & McCarthy database do not clarify which RBC words children should be able to produce versus comprehend at certain ages. A limitation of the RBC list, then, is that it potentially overestimates the number of RBCs children aged 7 and below use expressively. It is important to acknowledge that all the words on the RBC list may not be appropriate for every child at every developmental stage. Clinicians must consider the child's linguistic level and communication needs when selecting specific vocabulary. Nonetheless, receptive language plays a critical role in expressive language development; hence, children using AAC need exposure to vocabulary and models of its usage, even for words that are not yet part of their expressive vocabularies (Quick et al., 2019). A related limitation is the lack of normative information on the RBC list. Future research should investigate the typical order of acquisition for relational vocabulary, including those on the RBC list. Normative information

related to typically developing children, such as assessment norms, may be informative; however, its application to children learning aided language may still be limited.

This paper is intended to add to the ongoing discussion on vocabulary selection for children who use AAC and in doing so, attempts to invite other avenues for future research. For instance, there is a dearth of information regarding conceptual development among children with communication disabilities who use AAC (Moseley et al., 2021; Murray & Goldbart, 2009). Developmental research is sorely needed to understand how children acquiring aided language learn to use and comprehend relational words. In addition, scholarship in the AAC field is needed to illuminate the relationships between RBC knowledge, communication competence, non-linguistic cognitive skills, and academic achievement.

Beyond identifying and providing access to relational vocabulary, ongoing exposure and experience with the vocabulary should be considered an essential component of AAC based intervention. Intuitively, activities that provoke attention to relations in the world such as comparing, measuring, sequencing, evaluating, navigating, directing, and categorizing are likely to engender opportunities to hear and use relational vocabulary (Cooper et al., 2022). Such claims should be investigated by future research to uncover clinical intervention approaches that maximally support the development of relational language. For example, intervention studies can be conducted to determine if the incorporation of certain activities into therapeutic intervention such as construction-based activities, giving directions for action, or communicating unknown information, contributes to relational word production and comprehension (Batorowicz et al., 2016; Stadskleiv et al., 2018; Von Tetzchner, 2018).

2.6 Conclusion

Best practice for vocabulary selection in AAC advocates for a dual approach that incorporates both core and fringe vocabulary (Beukelman & Light, 2020). Drawing on assessments of basic concept knowledge for preschool and early elementary school students, we created a list of 156 relational basic concept (RBC) words that are important for school success, academic participation, and communication. Comparing our RBC list to nine widely used core vocabulary lists demonstrates some overlap between core words and RBC words; however, only two RBCs (*in* and *on*) overlapped on all nine of the core lists and 20 RBCs appeared on only one core list. Most RBC items included in our analysis were not captured on any core list. These results demonstrate that resources generated using a core approach have limited utility for identifying many RBCs that preschool and early elementary school students are expected to know and use. By extension, this study also raises concern regarding the prevailing dichotomy of core and fringe vocabulary in AAC research and practice because of its tendency to overlook relational words. Given their importance for language development, communication, and academic achievement, RBCs should be incorporated into vocabulary selection procedures, along with core and fridge words. Additionally, further consideration of RBCs within AAC research and practice is warranted.

2.7 Chapter 2 References

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2.8 Relational Basic Concept List

above	crooked	**in**	**new**	**some**
across	deep	**inside**	**next**	space
after	diagonal	inside-out	none	start
again*	**different**	**into**	**not***	**still**
ahead	**down**	joined	**off**	strong
alike	each	**just**	**old**	tall
all	early	large	**on**	**there**
almost	edge	**last**	**open**	thick
always	**else***	late	opposite	thin
another	empty	least	order	third
apart	end	left	**other**	**through**
around	enough	less	**out**	tight
away	equal	level	**outside**	**together**
back	**even***	**light**	**over**	**top**
backward	every	**like***	pair	toward
before	exactly	**little**	part	**turn**
beginning	except	**long**	**piece**	twice
behind	far	loose	quarter	**under**
below	fast	**lot/a lot**	**right**	underlined
beside/next to	few	low	**same**	unequal
best*	**finished/done***	**many**	second	**up**
better *	**first**	match	separated	upside-down
between	forward	medium	several	weak
big	fourth	**middle**	shallow	**whole**
bit*	**from**	missing	short	wide
both	front/in front	**more**	**side**	**with**
bottom	full	**most**	sideways	without
center	**gone***	narrow	similar	young
close	half	near	skip	
closed	heavy	nearly	skipped	
corner	**here**	neither	slow	
covered	**high**	**never**	small	

*Note***.** Bold words overlapped with one or more core word lists.

* Words not included in the Schwarz and McCarthy (2012) basic concept database.

3. Prompting for Repair as a Language Teaching Strategy for Augmentative and Alternative Communication

Cooper, B., Soto, G., & Clarke, M. (2021). Prompting for repair as a language teaching strategy for augmentative and alternative communication. *Augmentative and Alternative Communication.* https://doi.org/10.1080/07434618.2021.1979648

Recasts and self-repair have been found to play fundamental roles in the acquisition of language. This chapter describes existing research on self-repair, from both first and second language acquisition literature, and highlights its relevance to augmentative and alternative communication (AAC). Focusing on recasts and self-repair, Chapter 3 evaluates aspects of conversation-based interventions that support aided language learning, while also addressing features of SGD-mediated interactions that may hinder the efficacy of conversation-based intervention. Drawing from research in AAC, first language acquisition, and second language acquisition, I argue that self-repair is essential for both linguistic development and operational mastery of AAC systems; therefor conversation-based interventions should maximize opportunities for self-repair with speech-generating devices (SGDs). The chapter posits that explicitly encouraging aided output and providing prompts to self-repair with SGDs can increase opportunities for meaningful practice in pragmatically rich contexts.

Chapter 3 contributes to the overarching paradigm advanced in this dissertation by highlighting naturalistic conversation as a motivating and contextually rich setting for aided language teaching. Conversations within socially mediated activities can offer children authentic opportunities to produce aided output, refine their messages to resolve breakdowns, and build a deeper connection between graphic symbols and their communicative functions. The prompt-to-repair approach proposed in this chapter aligns with an action-oriented framework by positioning aided communicators as active agents in their language development (Clark, 2020; Tomasello, 2003), rather than passive recipients of input.

3.1 Introduction

Over the last three decades, there has been a growing interest in the language development of children who use aided augmentative and alternative communication (AAC), provoking several in-depth discussions about the unique aspects of their language learning experience (e.g., Gerber & Kraat, 1992; Light, 1997; Smith, 2006, 2015; Sutton et al., 2002; Von Tetzchner, 2018). These differences are often discussed in relation to the following aspects: (a) differences in representation (e.g., Soto & Olmstead, 1993; Von Tetzchner, 2015); (b) inter-modal asymmetry (e.g., Smith & Grove, 2003); (c) differences in production (e.g., Smith, 2015) and (d) differences in acquisition contexts with restricted access to sensory, motor, and social conditions that are known to be facilitative of language development (e.g., Light, 1997). Theoretical perspectives of aided language development typically reflect both the processes that are unique to the communicative situation of children who use aided AAC and those involved in typical language development (Smith, 2015; Von Tetzchner, 2018). In addition, because AAC systems use representational, syntactic, and semantic aspects to express meaning that are different from spoken language (Light & McNaughton, 2014), children learning to use aided communication can be thought of as learning two language codes simultaneously. Consequently,

theories from second language (L2) acquisition may also contribute to a theory of aided language development.

Theories of language development recognize the relevance of language input in acquisition processes, but children's language does not develop from exposure alone. According to social constructivism language is learned through social interaction with more competent children and adults (Bruner, 1975, 1983; Vygotsky, 1962; Von Tetzchner, 2018), a stance that is echoed by L2 scholars (e.g., Goo, 2019). A conversation between a novice speaker and an expert speaker emerges as the product of an interactional process, accomplished over time and incrementally, where both communication partners are constantly adjusting and responding to each other in ways that are relevant to the learner's language abilities (see Gass & Mackey, 2006 for discussion in L2 context). According to Brown (1968), the changes produced in sentences as they "move between persons in discourse may be the richest data for the discovery of grammar" (Brown, 1968, p. 288); however, researchers of typical development are divided on the extent to which children's language production (i.e., output) impacts their language development. For instance, Pinker (1994), suggests that the emergence of grammatical structures is not dependent on overt practice but made possible by linguistic exposure and innate language-learning constraints. This position has been widely contested by those who claim that children are not passive language learners but have an active role in their own language development (Clark, 2018, 2020; Tomasello, 2003; Vygotsky, 1962).

Research shows that, in conversations with young children, adults offer feedback with considerable frequency by checking up on unclear utterances when children make errors (Clark, 2020). When children detect a breakdown between their communicative intention and the message perceived by the adult, they often modify their output in an attempt to repair their original utterance. Modified output in the form of repairs is intrinsic to and ubiquitous in conversations between novice and expert speakers of any language and plays a critical role in language learning, whether children or adults learning their first (e.g., Clark, 2020) or second language (e.g., Goo, 2020). Children's use of words and grammar emerges from their generalizations of others' language use as well as their own. They learn appropriate word usage and rules of grammar by listening to (or seeing) language(s) used by others, as well as from using language, for various reasons in different contexts (Von Tetzchner, 2018). A core tenet of usage-based theory of language development (Tomasello, 2003) is that the child's experience with constructing and using language influences their language learning. Children's own production serves to develop the procedural skills required for language use, and also offers an opportunity to analyze and internalize the rules intrinsic to their language system.

In the context of early conversations with children, adult partners use a range of scaffolding techniques such as repetition, expansion, correction, and requesting clarification to scaffold children's participation in conversation, model conventional uses of language, and support children in generating their intended message (Chouinard & Clark, 2003; Clark, 2018, 2020). As children begin to combine words and grammaticalize, adults use these techniques to provide feedback on the grammatical accuracy of their utterances and to expand their language use. Children's output offers the adult insight into the system the child is constructing, and at the same time, reveals aspects of the system that require modification to conform to the conventions of their linguistic community. According to Wagner (1985), speaking children are estimated to produce as many as 20,000 words in a day, creating numerous opportunities for interaction and feedback. In contrast, an aided communicator may produce fewer than 20 utterances in the same time (Smith, 2006).

Although both speaking children and children using aided communication receive positive evidence (i.e., appropriate verbal language models) and feedback about their production, clinical experience suggests aided communicators are far more likely to receive feedback related to the content of their message or the accuracy of their operational skills than on the accuracy of their grammar (Smith, 2006). This observation is likely to reflect inherent challenges that graphic symbol use brings to conversational interaction. For instance, graphic symbols can be difficult to interpret and morphosyntactic elements are often unavailable or difficult to access (Light & McNaughton, 2014; Sutton et al., 2002; Von Tetzchner, 2015). In addition, explicit feedback may come at the cost of lengthening the time needed to construct a message and increasing demands on attention and memory (Von Tetzchner, 2018; Wilkinson & Hennig, 2009). Despite these challenges, command of morphology and syntax is necessary for achieving linguistic competence and can increase the frequency of successful communication, especially with unfamiliar listeners (Sutton et al., 2002).

Adult feedback has been recognized as facilitative of language development in aided AAC (e.g., Soto & Clarke, 2017, 2018), however a number of questions remain including what the most effective types of feedback are, and what role child repair plays in developing aided language competence (Binger et al., 2020; Smith, 2006, 2015; Von Tetzchner, 2018). The purpose of this paper is twofold: (a) to provide a brief overview of existing research on conversational repair as a language learning strategy, and (b) to suggest and provide justification for prompting conversational repair as a clinical strategy in language intervention for children who use aided AAC as they begin the process of grammaticalization.

3.2 Repair as a Language Learning Strategy

Repair is a term used within the conversational analysis literature to describe a range of features that are used by participants to manage problems in talk. These problems, or "troubles," may relate to speaking, hearing, and understanding the talk in conversation (Schegloff, 2000). Early work by Schegloff and colleagues (1977) identified two core stages in the realization of repair: initiation (i.e., displaying something in the prior talk as a troubled utterance) and outcome (i.e., what may be called the repair itself). They further noted that repair can involve either the self (the speaker of the trouble-source), other (someone other than the trouble-source speaker), or both. Four basic permutations of repair are thus possible: (a) self-initiated self-repair, (b) other-initiated self-repair, (c) self-initiated other-repair, and (d) other-initiated other-repair.

In the context of child language acquisition, young children monitor their language production as well as adults' responses and may engage in self-initiated self-repair when their communication partners appear to not understand their utterance (Clark, 2020). Example A from Clark illustrates how Brenda, aged 1;8 (years; months), uses repeated and progressively more accurate attempts at self-repair until her mother explicitly shows that she recognizes the word the child is attempting to say.

Brenda, holding up her mother's shoe and looking at it: Mama. mama. mama. mama.
sh. shi. sh. shiss. shoe. shoesh.
Mother: Shoes!

Research examining the occurrence of self-initiated self-repair in first language acquisition suggests that it aids the child in progressively mastering different aspects of language (Clark, 2020). Clark reported that children's self-initiated repairs at 2;0-2;4 years old prioritize phonological corrections (32%) over syntactic ones (3%). As they acquire more words and

master speech sounds, the proportion of self-initiated repairs dedicated to phonology decreases while repairs of syntax increase (6% and 23%, respectively, for children aged 3;5-3;8). Although Example A exemplifies a phonological repair, these findings suggest that the processes of self-monitoring, mental retrieval, and matching production to stored mental representations that occur during self-initiated self-repair may support the automatization of speech productions in terms of phonology and morphosyntax, gradually reducing the need for repairs (Clark, 2020).

3.2.1 Recast as a Form of Other-initiated Repair

Communication partners, including parents and language teachers, execute multiple strategies in order to signal that an error or "glitch" in a speaker's utterance was detected. Other-initiated self-repairs are commonplace in conversations between adults (Dingemanse et al., 2015) and between adults and children (Chouinard & Clark, 2003). Other-initiated repairs can take the form of open requests, which do not pinpoint the type of correction needed (e.g., hm?, huh?), and restricted requests, which underscore the information needing clarification (e.g. where?, who?) and make relevant a self-repair by the prior speaker. A third repair type, restricted offers (Clark, 2020; Dingemanse et al., 2015) are immediate reformulations of all or part of the speaker's problematic utterance with the error corrected. In the case of first language acquisition, restricted offers are commonly referred to as reformulations and have two purposes: to check up or confirm the child's meaning, and to provide a conventional way of saying the intended message without being obtrusive or disturbing the flow of conversation. This can be seen in Example B from Clark (2020):

Child (4;1): It might get loosed down the plug hole.

Adult: Lost down the plug hole?

In second-language learning contexts (e.g., Goo & Mackey, 2013) and in clinical settings (e.g., Baker & Nelson, 1984), the reformulation of an erroneous or imperfect utterance in order to provide feedback is typically referred to as a recast. A recast occurs when a communication partner responds to a learner's original (i.e., platform) utterance by reformulating it with one or more contrasting elements while maintaining its central meaning and incorporating at least some of the words from platform utterance. This reformulation, which can address any aspect of speech or language, is offered in the conversation turn immediately following the platform utterance.

Unlike open and restrictive requests, which make relevant a self-repair by the speaker (i.e., other-initiated self-repair), restricted offers, or recasts, simultaneously signal and resolve the problem. Thus, recasts serve as both the initiation of the repair and the repair itself (other-initiated other-repair; Schegloff et al., 1977). It is important to note that, although not required, recasts sometimes lead the speaker to repair their initial problematic turn following the recast, as demonstrated by the child's word change in Example C (Chouinard & Clark, 2003):

D (2;4): Don't fall me downstairs!

Father: Oh, I won't drop you downstairs.

D: Don't drop me downstairs.

Numerous studies have found recasts to be an effective intervention strategy for treating children with a wide range of speech and language impairments (see Cleave, 2015, for a review). Additionally, investigations of second language classrooms have found that recasts are the most frequent feedback move used by teachers (Brown, 2016; Lyster & Ranta, 1997). Recasts are thought to be effective, in part, because they follow immediately on the child's utterance, incorporate elements of the child's turn while maintaining its central meaning, and provide

contrastive comparison (see Saxton, 2005). According to the contrast theory of negative input (Saxton, 1997), the immediate juxtaposition of an erroneous statement with a corrected one provides the child with negative evidence and signals the need for a repair. Furthermore, because the recast is based on a joint attentional focus and maintains the child's original content, less cognitive load is needed for comprehending its meaning, and more processing energy can be used to analytically compare the two forms (Baker & Nelson, 1984; Chouinard & Clark, 2003; Nelson et al., 1996; Saxton, 2005). The same aforementioned affordances of recasts have also been extensively discussed in the context of second language learning and instruction (see Ammar & Spada, 2006; Ellis & Sheen, 2006; and Goo, 2020 for reviews).

In an analysis of five children in conversation with their parents, Chouinard and Clark (2003) found that adults reformulated up to two-thirds of their children's erroneous utterances. The children in the study frequently demonstrated evidence of attention to the adult's correction in their next turn through overt uptake (i.e., repair), rejection, acknowledgment, or repetition of information provided by the reformulation. Although immediate repair by the child followed, on average, less than 20% of adult reformulations, the findings provide evidence to support the view that children monitor and make use of the feedback provided by reformulations.

In the context of first language acquisition, the importance of immediate modified output has been debated (e.g., Camarata et al., 1994), and it has been suggested that for naturally speaking children acquiring their first language, immediate self-repair is not necessary for them to make use of the corrective feedback provided by recasts (Nelson, 2000). In contrast, more than two decades of empirical research in second language acquisition has yielded abundant evidence indicating that the production of modified output immediately following the provision of corrective feedback is an integral part of second language learning (see Lyster & Saito, 2010 for a meta-analysis). In L2 literature, modified output is described as a means for enhancing fluency and automatization of language production, as well as increasing metalinguistic awareness by bringing the learner's attention to the contrast between their utterance and the target language (Goo, 2019). The Output Hypothesis, proposed by Swain (1993), argues that second language learners need to be "pushed" (i.e., prompted) ... to reflect on their output and consider ways of modifying it to enhance comprehensibility, appropriateness, and accuracy" (p. 161). Several investigations have found that corrective feedback that elicits self-correction (e.g., open and restricted requests) are more effective for teaching linguistic targets to second language learners than recasts alone (Ammar & Spada, 2006; Ellis, 2015; Ellis & Sheen, 2006; Lyster, 2004). For example, Ellis (2015) suggests that second language learners may benefit from a combination of recasts and prompts to repair, with recasts providing models of new linguistic targets and prompts providing opportunities for learners to refine their prior knowledge through self-repair. Lyster (2004) argues that when students learning a second language are pushed to correct themselves without hearing a model of the correct form, they are required to retrieve information from long term memory, which increases mental activation and the likelihood that the linguistic item will be retrieved again in the future. These contributions from second language acquisition may theoretically offer some application to aided language development where accurate and efficient use of an AAC system is important for becoming an independent communicator (Light & McNaughton, 2014).

3.3 Interactional Features of Aided Communication Related to Self-Repair

Children learning aided communication are language learners. The interactional mechanisms underlying aided language acquisition, its content, and its form have attracted considerable attention from AAC researchers over the last three decades (see Smith, 2015 for an extensive discussion). The form of aided communication output in spontaneous conversations is often characterized by a predominance of single-symbol utterances, a persistence of simple clause structures that lack grammatical markers and inflectional morphology (even when these are available on the user's device), word-order differences from the local spoken language, and the use of numerous word strategies to compensate for the lack of appropriate vocabulary (Deliberato et al., 2018).

While all conversational interaction is co-constructed, one of the distinct features of aided conversations is the extent and manner to which communication partners work together in co-constructing the contribution of the person for whom the AAC system is provided (Clarke, 2016; Hörmeyer & Renner, 2013; Solomon-Rice & Soto, 2011; Von Tetzchner, & Martinsen, 1996). The process of co-construction typically starts with an utterance provided by the aided communicator, often a single word, that is not fully interpretable on its own. This utterance very often kicks off a series of guesses and specific yes/no questions by the speaking partner, which are accepted or rejected. Through guessing and follow-up questions the two individuals work through several turns to glean the intended message (Binger & Light, 2008; Clarke, 2016; Hörmeyer & Renner, 2013).

Within these types of everyday interactions children using graphic symbol-based aided AAC may use vocabulary items in strategic and creative ways to express meaning beyond the symbol gloss (Von Tetzchner, 2018); however, the use of aided AAC may also be limited by co-construction practices. For example, analysis of conversations between mothers and their children who use aided communication found that the mothers typically produced talk that did not solicit or require the use of aided AAC to continue the interaction and instead invited the use of unaided responses such as nods and smiles (e.g., Savolainen et al., 2020b). Furthermore, speaking children and children using aided AAC have been seen to bring about sequences that position the aided communication turn to a "pre-defined conversational slot (Clarke et al. 2013, p. 38)," such as a response to a question. This may be helpful for both partners because contingent replies produced via aided communication may be easier to understand and less likely to need repair (Clarke et al., 2013; see also Clarke & Wilkinson, 2007, 2008). In addition, such strategies may support positive, spontaneous interaction as they can minimize often significant time delays, effort, and operational demands inherent in aided AAC use. Nonetheless, these practices contrast with those seen in conversations involving typically developing children learning language (e.g., Waller & O'Mara, 2003) where adults embed recasts, prompts, and expansions into open-ended questions to help frame children's narratives and to stimulate further dialogue. Throughout this dyadic process, children may self-repair spontaneously or in response to adult prompts to repair.

The characteristics of co-construction seen in typical and AAC-mediated interactions, including strategies for resolving troubles with understanding, may be understood in relation to principles of conservation, specificity, and division of labor (Dingemanse et al., 2015). According to Dingemanse et al., when a person receives a message that they do not understand, they typically utilize a specific repair-initiator (i.e., restricted requests and reformulations) in order to efficiently signal the type of repair needed while suggesting that the rest of the message was understood, such as the repair-initiator who? presented in Example E (Dingemanse et al., 2015). The division-of-labor principle explains that listeners prefer to be altruistic, opting to

make repairs easier by using restricted requests and reformulations instead of less specific open requests such as huh? whenever possible. Among natural speakers, other-initiated self-repair is typically an efficient way to resolve misunderstanding.

Speaker A: Oh Sibbie's sistuh had a baby boy
Speaker B: Who?
Speaker A: Sibbie's sister.
Speaker B: Oh really?

These principles may be useful for understanding why naturally speaking communication partners appear to take on more of the co-construction work when conversing with aided communicators. Because aided communication can be laborious, slow, and extremely fatiguing speaking partners may be more inclined to put more effort into resolving breakdowns, possibly finding guessing and asking specific yes/no questions more efficient than relying on other types of repair initiators (Sorry? What?) when limited information, such as a single symbol, is provided.

In everyday interactions, co-construction is a positive and effective interactional resource that conserves time and effort for both partners and potentially maximizes successful exchanges (Clarke & Wilkerson, 2008; Savolainen et al., 2020b). Even so, a number of researchers have begun to question whether co-construction, as observed in practice and in naturalistic conversation, provides aided communicators with contrastive feedback and practice opportunities through self-repair that will support the internalization of language conventions and automatization of the operation of their communication aid (e.g., Binger et al., 2020; Von Tetzchner, 2018). Undoubtedly, the interactional experiences, acquisition systems, and expressive mechanisms related to typically developing children seem well suited to the task of language development without the need for explicit feedback or immediate self-correction. When adults provide corrective information via reformulations and other co-constructive strategies to typically developing children, immediate self-repair is optional, as was seen in Example C presented earlier. Speaking children, however, have the opportunity to retrieve and practice production of the target form in subsequent turns, especially if they are guiding the conversation. When aided communicators are engaged in a process of co-construction, they do not have the same opportunity to practice the production of new linguistic forms because they are typically responding to the questions and conjectures of their speaking partner. In addition, immediate repair after a recast may not be crucial for typical language development because the linguistic forms stored auditorily can be produced later using the same medium of speech. However, children learning language through aided AAC must learn to integrate spoken language with symbolic representations of language as well as the organization structure of their AAC system (Clarke et al., 2017; Smith & Grove, 2003). Verbal or aided AAC modeling alone may not provide sufficient scaffolding to support the integration of spoken and aided AAC language codes (Clarke et al., 2017). Similarly, linguistic input alone is often insufficient for mastering elements of a second language (Goo, 2019).

Given the complexities of many AAC systems, even if a child registered the corrective function of the recast, attended to the contrast, and processed the linguistic data, it is very difficult to ensure that they know how to access the enhanced version on their communication device. Aided communicators often have to navigate through multiple pages or screens to locate and select the desired vocabulary items, and many AAC programs are not conducive to grammaticalization (Binger & Light, 2008; Sutton et al., 2002). Without regular practice, the individual may struggle to execute the motor plan with the level of automaticity needed to make

communicating with the device efficient (Clarke et al., 2017; Ibrahim et al., 2018; Savolainen et al., 2020a; Soto & Clarke, 2017; Soto et al., 2019; Valencia et al., 2020). In the long term, persistent lack of self-repair may delay aided communicators' expressive language development and impact their learning of grammar, especially when compounded with operational challenges of aided AAC use; thus, immediate self-repair as part of language intervention and instruction may be especially important for children using aided AAC. Within educational or clinical intervention contexts, prompting a child to self-repair can conjecturally increase the noticeability of feedback, support the development of new language forms such as grammaticalization, provide opportunities for learning how to construct messages, and facilitate the procedural practice necessary for efficient word retrieval in the future (Clarke et al. 2017; Soto et al. 2019).

3.4 Prompting to Repair as a Clinical Strategy

Prior research in AAC has found a relationship between child output and learning of linguistic targets. For example, Romski and colleagues (2010) taught 62 young children with developmental delays single-word vocabulary that was individually chosen for each child and suitable for age-appropriate activities such as playing or shared book reading. Children were randomly assigned to three intervention conditions: (a) speech communication condition, whereby children were prompted to produce targets using speech only; (b) augmented communication input condition, in which target vocabulary was modeled using the children's speech-generating device (SGD) as well as with natural speech but the children were not expected to produce vocabulary items; and (c) augmented communication output condition, where adults modeled targets using speech and the children's SGD and children were prompted to produce the target words using their SGD. Results revealed that children who were expected to produce the target words on their SGD learned to use more augmented words than those who were taught the words but were not expected to produce them on their device. Although the focus of Romski et al. was on single-word vocabulary, the observed relationship between production and vocabulary growth can theoretically be extrapolated to other parts of language such as grammatical elements.

In later work, Soto and colleagues (2019) analyzed video data from a clinical conversation-based intervention study involving eight children between 8- and 13-years-of-age with motor speech disabilities who used SGDs. Data were extracted from earlier and later intervention sessions to investigate the relationship between different types of adult recast and child repair, and the relationship between child repair and later spontaneous use of linguistic targets. Spontaneous use of target items during later intervention sessions was significantly and positively related to earlier conversational sequences in which adult recasts included targets that the participants used in a repair of their prior turn, pointing to a relationship between child repair and distal spontaneous use of linguistic targets. Furthermore, the rate of repair varied according to recast type, with participants repairing more often when they were directly prompted to do so and when they were presented with an interrogative choice recast, which necessitated a reply using their SGD.

Similarly to L2 literature (see Ellis, 2015 for L2 context), recasts and prompts to repair are believed to serve different functions in aided language intervention. Recasts are considered beneficial because they provide the learner with opportunities to directly contrast their utterance with one that is grammatically improved (Binger & Light, 2008; Clarke et al, 2017). A prompt to repair delivered after multiple turns of co-construction can shift the focus of a clinical interaction from negotiating meaning to language instruction (Savaldi-Harussi et al., 2019; see Lyster, 2004

and Lyster & Ranta, 1997 for L2 classroom context). Prompts to repair encourage the learner to attend to the new linguistic information and reformulate their message accordingly. Prompts also offer opportunities for language construction and familiarization with the language infrastructure of the device during meaningful learning experiences.

Recent studies offer preliminary support for combining recasts and prompts to repair in clinical conversation-based interventions (Luckins & Clarke, 2019; Soto & Clarke, 2017, 2018). In Soto and Clarke's clinical studies with children and youth who used SGDs, clinicians used participant-relevant photos and other artifacts as a context for conversation. When the participants generated an utterance, the clinician asked a series of questions to elicit different sentence constituents and glean the complete message. Once the message was understood, the correct form was then recast and the clinician prompted the participants to modify their original utterance using grammatical elements that were previously absent, as in the example below. The clinician used verbal and gestural prompts to assist the participants in locating the necessary targets. Younger children demonstrated improvement in all of the grammatical targets (pronouns, verbs, and bound morphemes) as well as their spontaneous production of clauses. Among the adolescents, all four participants improved in their use of at least one linguistic target, and three increased their use of spontaneous clauses. These changes were generalized to conversations with familiar adults and peers who were blind to the intervention strategies.

Adult: Do you remember how old were you? (looking at a photograph of the child)
Child: "Nine years old."
Adult: You were nine years old. Let's make that a full sentence. I was
Child: "I was nine years old."
Adult: What else do you remember about that day? Tell me about it.
Child: "Dad mom"
Adult: So remember, we're using our complete whole sentences, right? So you would say: This is mom and dad.

Luckins and Clarke (2019) replicated these procedures in another study including four children with partially intelligible speech and receptive and expressive language delays. These children, for whom speech was their primary mode of communication, used SGDs to repair unintelligible natural speech. During intervention, the clinicians asked the participants about a personally relevant photo, recast the child's utterance into a full verbal clause, modeled the target clause on the child's SGD, and prompted the child to repair. Their intervention was effective in increasing the rate of self-initiated clauses by all children. Three out of four children also showed increases in the total number of words used within clauses, with more moderate gains in the use of fully grammatical sentences. Linguistic gains also generalized to conversations with adults unaware of the intervention strategies.

In both the Soto and Clarke (2017, 2018) and Luckins and Clarke (2019) studies, recasts were combined with prompts to repair to teach grammatical targets such as pronouns, prepositions, articles, verbs, and inflectional morphology, among others. While the level of participant operational competence in AAC prior to intervention may have influenced outcomes, the results of these studies provide positive preliminary evidence for combining recasts with prompts as a clinical intervention strategy within conversation-based intervention for individuals who use aided AAC and are learning to use grammar.

3.5 Implications for the Use of Prompts to Repair in Aided Language Intervention

Preliminary research evidence suggests that encouraging aided communicators to repair their utterances after a recast has promise as an effective clinical intervention strategy to promote language learning; however, effective communication with an aided communicator will continue to benefit from co-construction for efficient and functional communication. Individuals who use aided AAC are a unique population requiring intervention approaches that are tailored to their exceptional needs. Many children who use aided AAC present with characteristics that are consistent with language-learning disabilities. Their messages tend to show an overall immaturity in grammatical structure, including difficulties with pronouns, syntax, verb morphology, elaboration of interrogative, negation, and complex sentences (Binger & Light, 2008; Sutton et al., 2002). They typically have a late onset and a slower rate for learning specific grammatical features (Smith, 2015). Due to the interaction between the complex nature of their disabilities and the complexities of using aided AAC to learn language, it is often challenging to parse out the nature of their difficulties in acquiring grammar.

Language intervention for children who use aided AAC is a long term, complex, and multi-modal process that requires systematicity and time. Due to their heterogeneity in etiologies, communication aids, receptive/expressive language profiles, level of AAC competence, etc., intervention strategies need to be selected and modified according to the target skill and the language needs and the capacities of each individual client (e.g., Beukelman & Light, 2020). Children's language acquisition typically develops at the crossroads of the appropriation of the linguistic system and its use in dialogue (Morgenstern et al., 2013). Children acquiring language via aided communication find themselves at an intersection of learning their first language and learning to use a communication system with different representational features and unique encoding demands, which can arguably be likened to aspects of learning a second language. Because of this, discerning effective treatment approaches for facilitating language growth by people using AAC may draw on contributions from the fields of communication disorders, typical language acquisition, and second language learning.

There are many users in the early stages of communication development for whom a focus on form rather than content may not be warranted or desirable as it can potentially disturb the flow of the conversation, increase operational and cognitive demands, decrease motivation, and limit interactional opportunities for authentic use (Von Tetzchner, 2018). It is therefore critical to understand how, when, and with whom to use different types of feedback. Combining recasts and prompts for repair may serve to maximize the benefits of grammatical intervention for children who use aided AAC and are beginning to combine symbols into longer utterances, by maintaining a client-centered approach that provides sufficient feedback and opportunities for practice. When constructing grammatical interventions for children with language challenges, Fey et al. (2003) prescribe maximizing the "frequency, saliency, meaningfulness, and opportunity to make use of target grammatical constructions" (p. 5). Combining recasts with prompts for repair during intervention elevates the saliency of the linguistic contrast and increases the likelihood that the feedback is accurately registered. Prompting for repair increases the opportunity for practice, which can contribute to automaticity and allow the client to make use of the target in the future.

Language therapy that encourages output using prompts for repair is distinct from pure imitation or decontextualized language performance. Utilizing a conversation-based intervention approach focusing on events that are meaningful and motivating to the child, with implicit and explicit feedback plus opportunities for practice, can provide rich language intervention. Recasts, and conversation-based therapy in general, appear to support linguistic growth in part because

they are child-initiated and provide greater interactional opportunities than drill-based tasks. Combining prompts with recasts increases the saliency and frequency of new grammatical forms while maintaining the meaningfulness of discourse-based intervention for individuals learning to use AAC (Luckins & Clarke, 2019; Soto & Clarke, 2017, 2018).

In addition to improving direct intervention practices, incorporating such an approach may have significant implications for generalization of newly acquired linguistic skills to novel situations. Clinicians working to develop the linguistic skills of individuals using AAC may consider coaching other members of the educational team to incorporate target-specific recasts (Camarata & Nelson, 2006) and prompts for repair during appropriate learning opportunities in an intervention or education context. As previously discussed, recasting is a natural part of communication when one attempts to converse with a less competent communicator, whether it be children, non-native speakers, or those with communication impairments; thus, instructing potential communication partners to execute this intervention strategy can boost the opportunities for practice across various situations, activities, places, and contexts.

It is important to underscore that not every interaction with an aided communicator should incorporate prompts for repair or that children should always be expected to replicate adult models in full. A person who uses AAC may be less likely to communicate if always met with corrective feedback and prompts to repair. Co-constructive strategies as described above will continue to be critical for expedient, functional, and positive interactions between aided communicators and their communication partners. Supporting a person to express their intent and feel heard should always precede a prompt to repair. It is proposed, however, that prompting to repair as a teaching strategy be carried out in clearly defined intervention or education sessions. Prompts should be used to elicit a limited set of intervention targets, presented in recasts, that are within the child's zone of proximal development (Vygotsky, 1962). Selecting appropriate intervention targets is a critical aspect of recast-based interventions but beyond the scope of this paper (see Binger, et al. 2020; Eisenberg, 2013, 2014; Kamhi, 2014). In addition to the individual's linguistic level, communication partners should be mindful of the individual's affect, such as motivation and anxiety, to maximize the potential for language learning (see Goo & Takeuchi, 2021 for a discussion of feedback and affect in L2).

3.6 Limitations and Future Directions

Much research is needed to investigate how prompts to repair may influence the efficacy of recasts among aided communicators, and to describe how input and output work together to facilitate language learning in aided AAC. Current evidence suggests that intervention incorporating recasts in addition to explicit requests to repair has demonstrated promising preliminary results in children's language use (Luckins & Clarke, 2019; Soto & Clarke, 2017, 2018; Soto et al., 2019). To date, however, such research has incorporated recasts and prompts to repair within broader intervention packages. Isolating specific procedures (e.g., questions, recasts, prompts to repair) to analyze their separate effect as well as order effects is, therefore, warranted. Researchers interested in investigating the differential effects of recast input versus output may consider replicating second language acquisition studies that compare recasts to other types of prompts provided during instructional interaction (e.g., Lyster, 2004). In addition, employing randomized control studies that compare this approach to recast-only and prompt-only treatment is necessary to draw further conclusions.

A second limitation of this recast-plus-prompt approach is that, like most interventions, it may not be suitable for every child, situation, or language goal. For example, it may not be

beneficial for some therapeutic objectives such as increasing overall frequency of self-expression or AAC use. More information is also needed about the type of linguistic target and the level of operational and linguistic competence most susceptible to this type of strategy. Here too, recast research conducted in the context of second language learning may offer a framework for such investigations. For example, Ammar and Spada (2006) found differential effects of recasts and prompts between high-proficiency and low-proficiency second-language students.

Because those who use AAC are heterogeneous in terms of AAC system, language ability, and diagnosis, language intervention studies that support participants' use of their own communication systems in authentic discourse-based tasks may be well suited to support generalization of learned skills to everyday conversation. The field of AAC is in serious need of continued research that aims to discover effective and meaningful language intervention strategies. Expanding the recast research agenda to aided communication requires a nuanced approach that brings together findings from first language acquisition, second language acquisition, communication disorders, and AAC research.

3.7 Chapter 3 References

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4. "Building Relational Vocabulary Together": Exploration of a Relational Vocabulary Teaching Tool for Students Using AAC

Chapter 4 represents a critical transition in this dissertation, moving from research to practice. Building on the theoretical contributions of Chapter 3, which emphasizes the importance of situating intervention within genuine interaction, Chapter 4 extends this action-oriented perspective by centering clinical interactions within joint-action. While Chapter 3 highlights the necessity of children actively producing language during conversation rather than passively learning receptively, Chapter 4 takes this further by incorporating sensorimotor experience as a foundational component for teaching relational vocabulary.

This chapter introduces Building Relational Vocabulary Together (BRVT), a novel instructional tool designed to facilitate relational vocabulary learning for children using speech-generating devices (SGDs). BRVT is grounded in sociocultural, constructivist, and embodiment theories and informed by the design principles of embodied design (Abrahamson, 2014) and Special Education Embodied Design (SpEED; Tancredi et al., 2022). The BRVT task is a collaborative, barrier-style game that encourages children to use relational vocabulary to describe contrasts in size, movement, and spatial positioning. By requiring participants to actively engage with relational language to achieve shared goals, the intervention centers interaction and joint action as mechanisms for learning.

The study presented in Chapter 4 evaluates the feasibility of BRVT as a pedagogical tool for teaching relational vocabulary. Rather than assessing direct learning outcomes, the analysis focuses on how the intervention's design creates opportunities for interactional processes known to facilitate aided language learning. Specifically, the chapter examines how BRVT supports the grounding of graphic symbols in sensory experience, the establishment of common ground, and opportunities for self-repair using SGDs. This design-based research project demonstrates how an intervention grounded in action and interaction can create rich conditions for teaching and learning relational vocabulary. Through this lens, Chapter 4 aims to provide a pathway for integrating relational vocabulary into AAC practice while further advancing the overarching paradigm of this dissertation.

4.1 Introduction

Relational vocabulary are non-noun and non-verb words that describe relationships between people, objects, events, and situations. They can refer to spatial position (e.g., under), movement (e.g., away), presence (e.g., gone), size (e.g., small), dimension (e.g., thick), quantity (e.g., many), and time (e.g., before; Boehm, 2004; Cooper & Soto, 2024). Relational words are a ubiquitous part of everyday communication, allowing us to tell stories, recount events, describe objects and situations, share our observations, comment on activities, and direct the actions of others (Cooper et al., 2022). In addition, knowledge of early emerging relational words is associated with academic success in early childhood, correlating with language (Steinbauer & Heller, 1978), numeracy skills (Chan et al., 2022; Lindner et al., 2022), reading (Gallivan, 1988) and math achievement (Estes, et al.,1976; Busch, 1980).

Aided AAC refers to a range of communication systems that utilize external tools, including speech-generating devices (SGDs), to support or replace spoken communication for individuals with various diagnoses or conditions affecting speech (Beukelman & Light, 2020). Evidence from a small number of studies suggests that children with motor-speech disorders

using AAC show a relative weakness in expressing relational words compared to nouns, verbs, and non-relational adjectives (e.g., color, shape) when giving directions or describing scenes to others (e.g., Batorowicz et al., 2016; Stadsleiv et al., 2018) even when the vocabulary is available on their SGDs. Limited fluency with relational vocabulary may negatively impact autonomy, participation, and social interaction for individuals who communicate with AAC.

There is a need to address the absence of evidence-based interventions and pedagogical resources that may support relational vocabulary development among children learning to use AAC. The present study explores the feasibility of a novel education tool called Building Relational Vocabulary Together (BRVT) that aims to teach children to expressively use relational vocabulary on their SGDs. We seek to interrogate how the activity creates opportunities for interactional processes that are known to facilitate aided language learning — adult reformulations of children's utterances, grounding of symbols to concrete sensory experience, and output practice using SGDs. Rather than assessing direct learning outcomes, our analysis examines how BRVT's design features mediate these interactional mechanisms that are considered conducive to language development via AAC, thereby supporting the use of graphic symbols representing relational vocabulary. Understanding how to best activate these mechanisms will inform clinical approaches that leverage meaningful, child-directed activity as a context for teaching important vocabulary.

4.2 Theoretical Foundation and Design Principles

Prior scholarship on relational concept development, language acquisition, and AAC-mediated intervention shaped the theoretical foundation for BRVT's design and the data analysis presented here. Section 4.2.1 examines a pragmatic account of linguistic feedback provided through reformulations. Section 4.2.2 addresses grounding symbols in embodied experience, and Section 4.2.3 reviews the role of output practice in AAC. In these sections, I summarize key literature relevant to each aspect, consider its application to SGD-mediated intervention, and outline how each aspect informed the design objectives of BRVT.

4.2.1 A pragmatic account of reformulations

Social interactions provide opportunities for children to practice new communicative behaviors and for adults to shape children's contributions through linguistic input and feedback (Chouinard & Clark, 2003, Clark, 2020). Interactive repairs are an ever-present feature of naturalistic conversations and are a key resource for providing feedback, maintaining mutual understanding, and enabling joint activity (Dingemanse & Enfield, 2024). Reformulations, called recasts in the context of language intervention (Camarata et al., 1994) and other-initiated other-repair in conversation analysis (Schegloff et al., 1977), is one type of interactive repair that is considered a formidable driver of language acquisition (Chouinard & Clark, 2003). Reformulations occur when a communication partner immediately responds to a learner's utterance by reformulating it to provide a corrected and/or expanded model of the prior turn, using new elements while preserving the core meaning and some of the original words (Clark, 2020; Clarke et al., 2017).

A pragmatic approach to language acquisition (Chouinard & Clark, 2003; Clark, 2018) offers an explanation as to how children discern the corrective nature of reformulations from other types of linguistic input from adults. Pragmatic approaches to acquisition posit that children attend to the pragmatic function of partners' speech and are sensitive to the cooperative

nature of conversation (Chouinard & Clark, 2003; Tomasello, 2008), namely that contributions typically should be relevant for advancing the current interaction (Grice, 1975). When a child's utterance is responded to with a reformulation that maintains the same meaning, the child has the opportunity to directly contrast their utterance with the improved form. Parity of meaning between the child's platform utterance and the adult's reformulation, then, is crucial for the child to recognize that the adult's turn contributes to the interaction by offering a more conventional way to express the same intention, rather than merely advancing the conversation.

The effectiveness of reformulations, or recasts, in clinical language intervention is supported by a body of evidence (see Cleave et al., 2015 for a review). In both naturalistic and clinical conversations, establishing mutual understanding, or 'common ground,' is a necessary step for providing children with recasts that accurately reflect their intended meaning. Mutual understanding refers to the shared understanding between individuals engaged in situated joint activity where both parties recognize, acknowledge, and signal their mutual attention to a topic, idea, or object (Clark, 1996; Tomasello, 2008). It also requires comprehending, and signaling comprehension, of each other's intentions within a shared context (Tomasello, 2008).

Mutual understanding is maintained not only through verbal exchanges but also by utilizing embodied multimodal cues, including gesture, gaze, and artifacts. In AAC-mediated language intervention, consideration of multimodal forms of communication is particularly relevant because aided communicators often use creative multimodal strategies to compensate for limited communication resources (Neuvonen et al, 2022a). However, with limited access to symbolic communication and bodily control, partners may have trouble ascribing meaning to subtle multimodal signs especially without shared context (Ibrahim et al., 2023; Light et al., 1985; Neuvonen, 2022b). In conversations involving aided communicators, barriers to establishing mutual understanding hinders opportunities to provide recasts because they depend on the speaking partner's grasp of the aided communicator's intended meaning.

A well-documented feature of AAC-mediated conversation that contributes to the accomplishment and maintenance of mutual understanding is co-construction (e.g., Neuvonen et al., 2022b; Solomon-Rice & Soto, 2011). All conversation is co-constructed in various ways by communication partners; however, in the context of AAC, the focus of co-construction is often the explicit negotiation and construction of the AAC user's contributions. Co-construction can be described as a collaborative process of building shared understanding by deploying linguistic and multimodal resources—including guesses and yes/no questions—to construct the contribution of the person using AAC through a series of conversational turns (Savolainen et al., 2018). Although an effective resource, particularly among familiar partners (Neuvonen et al., 2022ab; Savolainen, et al., 2020), the process of co-construction can require several turns before the complete message is understood, leading to extended time and structural variation between the child's initial platform utterance, which may be a single word or gesture, and the final recast provided by an adult (Clarke et al., 2017; Cooper et al., 2021).

Embedding recasts into conversation-based intervention for children who communicate with AAC has demonstrated positive outcomes for increasing utterance length and use of morphosyntactic structures (Soto et al., 2020; Soto & Clarke, 2017; Soto & Clarke, 2018); however, the time and number of conversational turns required to reach mutual understanding may influence the effectiveness of recasts as a language teaching strategy (Cooper et al., 2021). Facilitating a more efficient process for achieving understanding of the aided communicator's intended meaning may increase the saliency and impact of recasts as a teaching technique. Successfully establishing common ground in AAC-mediated conversations is highly influenced

by shared context and the availability of semiotic resources (Ibrahim et al., 2023). Motivated by a pragmatic approach to recasts, we aimed to design an intervention context where mutual understanding can be established efficiently by leveraging numerous multimodal and environmental resources. By designing for mutual understanding, BRVT can theoretically increase opportunities for recasts involving relational vocabulary.

4.2.2 Grounding graphic symbols in embodied experience

Word learning, especially words for abstract or relational concepts, is a complex process of word-to-world pairing that is influenced by a plurality of factors and mechanisms (e.g., Bowerman & Levinson, 2001; Gleitman et al., 2005; Hespos & Spelke, 2004). A family of theories under the umbrella of embodied cognition offer accounts of how the body and environment drive cognitive development, including language and relational thinking (Richardson et al., 2008; Varela et al., 1991; Wilson, 2002). Embodiment theories counter the notion that language and learning as purely mental processes and instead posit all cognition as fundamentally constituted by the body's interactions with its environment (Gallese & Lakoff, 2005; Glenberg & Kaschak, 2002). A hallmark of embodied cognition is that we come to understand words, including words for abstract concepts, by grounding them in direct sensorimotor experience acquired through interaction with the social and physical world (Barsalou, 1999; Glenberg & Gallese, 2012; Harnad, 1990; Kiverstein & Rietveld, 2018).

Contemporary theories of embodied cognition agree with Piaget's argument that early sensorimotor experience provides foundational information about the world that forms the building blocks for later conceptual development (Piaget, 1952/1936; Wellsby & Pexman, 2014). Embodiment theories have also been put in dialogue with Vygotsky's sociocultural learning theory, which argues that conceptual knowledge emerges and is continually reshaped through participation in language-mediated social activity (Shvarts & Abrahamson, 2023; Vygotsky 1978). Vygotsky's theory highlights how the meaning of symbols, particularly words, evolves through the child's participation in socially situated joint actions. Through these interactions, symbols acquire shared meaning, which is then internalized and shapes cognitive development (Mahn & John-Steiner, 2012; Vygotsky 1978).

The Co-operative Action framework (Goodwin, 2018) offers a specific account of how humans come to imbue meaning on symbols during embodied social interactions and provides conceptual tools for analyzing the mechanisms of symbol grounding. This framework describes how individuals reuse, transform, and operate on varied semiotic materials in the environment—linguistic, non-linguistic, and material artifacts—as tools for organizing action, mediating understanding, and constructing meaning in interaction. Within a given interaction and across longer time scales, partners continuously take up, transform, and accumulate semiotic resources—both linguistic and nonlinguistic—to shape attention, maintain common ground, and negotiate the consensual meaning of symbols.

Facilitating the construction of symbol meaning is a fundamental element of AAC-based intervention, particularly for individuals who are not yet literate and rely on pictographic representations of vocabulary. To effectively use graphic symbols representing relational vocabulary, the meaning of the symbol must be conceptually connected to the environmental phenomena and the social functions to which it conventionally refers. However, children who use AAC often have physical and social experiences that are different from typical developing children and can limit opportunities for a child to anchor a graphic symbol to its referent in the world through concrete sensory experience (Light, 1997; Light & Kelford Smith, 1993). For

instance, children who use AAC often experience barriers brought on by impaired mobility, exclusion from sociocultural activities (e.g., school field trips, parties), reduced opportunity for child-directed play, and more.

Another important consideration is referred to as *input-output asymmetry*. Children learning to communicate with aided AAC, including high-tech SGDs, experience asymmetrical channels of language, namely receptive spoken language and graphic expressive language (Smith & Grove, 2003). Typically developing children, on the other hand, both hear and produce language using the modality of spoken speech (i.e., input-output symmetry). Beginning in infancy, children come to map, or ground, spoken symbols that they hear (i.e., words) onto the perceptual, motor, and environmental experience that it applies (Glenburg & Kaschak, 2002; Gleitman et al., 2005) and refine their ability to appropriately use those spoken symbols through practice in conversation (Clark, 2020; Tomasello, 2003; Vygotsky, 1978). The input-output asymmetry experienced by children acquiring aided language requires them to learn how concepts in the world are represented by the spoken code of their linguistic community as well as the graphic representations on their communication aids (Light & McNaughton, 2014). This presents a three-way grounding problem, wherein children who use AAC must integrate graphic representations with spoken words *and* direct sensory experience to construct the meaning of a graphic symbols in AAC (Figure 1). Unfortunately, the external nature of aided communication systems can make it difficult for caregivers and educators to structure the child's environment to allow simultaneous access to the communication system and objects during play and routines (Von Tetzchner & Martinsen, 1992). As a result, interactions are more likely to support connections between sensorimotor experiences and spoken words or between spoken words and graphic symbols, while integrating all three simultaneously can be more challenging.

Figure 1.

Three-way grounding problem: Integrating spoken word, pictographic representation, and sensory experience for grounding the meaning of graphic symbols in AAC.

Teaching approaches rooted in embodiment theories call out the limited efficiency of teaching semiotic activity outside of purposeful goal-oriented activity. Instead, these approaches emphasize the importance of creating problem-oriented material environments where sensorimotor engagement and social interaction can facilitate perceptual orientation to task-relevant relations and the semiotic value of symbols can emerge (Abrahamson, 2013; Shvarts & Abrahamson, 2023). Creating such an environment for AAC intervention requires consideration of how symbol meanings emerge in typical development while accounting for the unique needs of children developing spoken receptive language and graphic expressive language. Drawing from an embodied perspective, BRVT was designed to support symbol grounding by engaging

learners in perceptual-motor experiences with relational concepts within a dynamic, goal-oriented task environment. The design also aims to facilitate the integration of graphic symbols, spoken language, and environmental conditions through a socially mediated joint-action task.

4.2.3 The role of output in aided language development

Beyond learning to integrate these graphic symbols with spoken language, children learning to use SGDs must also develop operational skills to access the symbols during message construction (Clarke et al., 2017; Cooper et al., 2021; Smith & Grove, 2003; Soto et al., 2020). Children who rely on SGDs need opportunities to practice message construction so they can master the operational infrastructure of their system (Clarke et al., 2017; Cooper et al., 2021).

One approach for facilitating expressive ability is to encourage and support children to repair their utterances using their SGDs (Luckins & Clarke, 2021; Soto & Clarke, 2017, 2018; Soto et al., 2020). Soto et al. (2020) examined video data from a conversation-based intervention study involving children with motor speech disabilities using SGDs. Their findings showed a positive relationship between child self-repair in earlier sessions and later spontaneous use of those linguistic targets that they had previously self-repaired. However, self-repair using SGDs can be a cognitively demanding task for children. SGDs for individuals who are not yet literate, typically use graphic representations of vocabulary on a grid that must be selected in order to generate synthesized voice-output. The organization of vocabulary can be complex; users typically have to navigate through embedded folders, sometimes requiring multiple hits to locate a desired symbol. This creates significant attention and memory demands for SGD users, who must search for the words they need, attend to the ongoing interaction, and remember their intended message—all while ignoring distractors in both the array and their environment (Thistle & Wilkinson, 2013; Wilkinson & Hennig, 2009). These demands can become more challenging for children with motor impairments using alternative access methods (Sowers & Wilkinson, 2022).

The operational demands of SGDs are pertinent for designing interventions targeting relational vocabulary. McCarthy et al. (2017) assessed the availability and accessibility of 285 basic concept words (relational and non-relational concepts) across four communication software. They found that the average number of ‘hits’ needed to access basic concept words was two, with some requiring up to four. Moreover, relational vocabulary can be organized within a plurality of folders or categories, such as size, time, opposites, describing words, etc., which may further burden cognition and memory. As a result, supporting students to produce relational vocabulary with their SGDs benefits from the deployment of numerous clinical strategies, such as direct instruction, modeling, verbal and gestural guidance, and fading cues (Beukelman & Light, 2020; Wandin et al., 2023).

Opportunities for self-repair can be limited by both social and environmental conditions. In naturalistic conversation, speaking partners often direct and structure conversations so that unaided contributions (e.g., smiles, vocalizations, body movements) by the aided communicator can be readily interpreted (Savolainen, et al., 2020). Although a useful strategy for limiting misunderstandings, this pattern of interaction can limit opportunity for practicing new linguistic forms on their SGDs. In addition, previous research has questioned the noticeability of conversational recasts within SGD-mediated conversation, suggesting that children using SGDs may not recognize the opportunity for self-repair unless the expectation is explicitly signaled (Cooper et al., 2021; Soto et al., 2020). Finally, the fast-paced nature of face-to-face conversations, along with ever-shifting environmental conditions, presents an additional

challenge for children using SGDs, who often need more time and scaffolding to produce responses. As situated contexts and referents in the environment change, the need and opportunity for self-repair can be fleeting, reducing opportunities to practice SGD output in real time.

BRVT was designed to maximize practice opportunities for producing relational words on SGDs by incorporating ample opportunities and scaffolds for self-repair. To accomplish this design objective, BRVT was crafted to explicitly solicit the use of relational vocabulary while minimizing demands on attention and memory.

4.3 Purpose

The purpose of this study was to assess the feasibility of a pedagogical tool designed to teach children how to expressively use relational vocabulary on their speech-generating devices. Specifically, we aim to demonstrate how the activity mediates interactional processes that are known to facilitate learning and support the use of graphic symbols for relational concepts (i.e., recasts, symbol grounding, and output practice). Our research question is: in what ways, if any, does the BRVT activity create conditions for the following design objectives: (a) establishing mutual understanding (b) integrating sensory and linguistic experience, and (c) supporting self-repair using SGDs?

4.4 Methods

4.4.1 Research Design

This study uses a design-based research (DBR) approach. DBR is an approach to education research that iteratively develops, tests, and refines theory-driven learning interventions in real-world settings (Bakker, 2018). DBR aims to advance learning theories while addressing practical educational challenges through cycles of design practice. This study reports from an investigation of a novel teaching tool, aiming to contribute to both theory and practice in AAC intervention research.

4.4.2 Participants

Classroom teachers with students who use AAC were contacted by email with information about the study. Teachers were invited to share the recruitment flyer with parents of children that met the recruitment criteria. Participants were eligible if they met the following criteria based on teacher interview: (a) were between 4 and 14 years old; (b) had a developmental disability that impacted their ability to use speech functionally; (c) used a high-tech speech generating device (SGD) with software that allows for vocabulary organization and grammaticalization; (d) used their SGD regularly for over 6 months; (e) had relatively reliable access methods; (f) used English as a dominant language; (g) presented with hearing and vision within normal limits, with or without correction.

The data for this study was taken from a larger study looking at the effects of participating in a barrier game activity on the acquisition of relational vocabulary by children who use SGDs. The current study focuses on two students Emily and Diego. Both participants are enrolled in a special education classroom in a middle school.

Emily is a 14-year-old girl from a monolingual English-speaking family. She is diagnosed with Down Syndrome. Part of her communication system includes Proloquo on a 12-inch iPad, which she accesses using direct selection. She uses Intermediate Core vocabulary arranged on an eight by four grid layout. In addition to her SGD, she uses pointing, nods, and gestures. She does not typically use her voice for speech, but she will occasionally say things like whoa, hey, no. She also expresses herself through gasping, squealing, signs, growls. Emily is a context-dependent communicator (Beukelman & Light, 2020), meaning she uses a relatively limited set of symbols to talk about specific topics in specific contexts or activities. She combines multiple symbols but does not typically use grammatical markers. Emily has delayed gross motor abilities; however, she is ambulatory and walks without assistance.

Diego is an 11-year-old boy who receives English-only instruction in school and is exposed to English and Spanish at home. Diego is also diagnosed with Down Syndrome. His SGD is a 12-inch iPad with Proloquo. He uses the Intermediate Core vocabulary on a six-by-six grid array. Diego often uses his voice, but his speech is highly unintelligible. Diego is a context-dependent communicator who uses a combination of verbal approximations, nods, gestures, and symbols. He will combine multiple symbols with encouragement and guidance but does not typically use grammatical markers. Diego's gross motor abilities are within the expected range for his age. He walks without assistance and uses direct selection to access his SGD.

4.4.3 Materials

BRVT is a novel educational activity using a barrier-game format. A barrier-game is any activity wherein partners sit with a barrier and have to convey information that is unknown to their partner. BRVT includes a 30-piece set of farm-themed artifacts, a game board, 25 cards depicting the artifacts in various arrangements, and an illustrated storybook. The artifacts and cards were purposefully designed to elicit a wide range of relational judgements and relational vocabulary.

4.4.3.1 Game artifacts

A set of farm-themed toys was created to encourage diverse relational judgments and elicit relational vocabulary (Figure 2a). To elicit the use of relational modifiers within the activity, the artifacts were designed to either contrast within a particular domain (e.g., size, height) or to solicit relational contrasts during gameplay through movement or spatial position. The game artifacts are two horses (contrast by dark/lightness, head position moves up/down), two pigs (contrast by height and width), two dogs (contrast by number of spots), 12 identical ducks, a tractor, 3 wagons (contrast by color), a bridge, two tree trunks (contrast by height and width), two tree canopies (contrast by shape), two fences (contrast by height, can be extended and contracted along horizontal access), a silo (broken into 4 stacking parts), and a barn (two doors on hinges). The majority of pieces were printed using a Prusa™ 3D printer. The majority of pieces were created by purchasing STL files online and modifying them with Fusion 360™ software. The fences, barn, and wagons were created on Fusion 360™ by members of the research team.

Figure 2

Game Artifacts

(a)

Farm-themed toys, cards, and story book arranged on the game board

(b)

BRVT game board illustration

4.4.3.2 Cards

25 photographs were taken of the game artifacts on the game board. The arrangements were chosen by the first author with input from members of the research team. The photographs were 6”x8” printed on 8 1/2” x11” cardstock. Two to seven artifacts were included in each photo. To elicit a wide range of relational vocabulary throughout the study, the cards featured different combinations of artifacts arranged in various positions and configurations.

4.4.3.3 Board

A member of the research team illustrated the game board to resemble a field (Figure 2b). The image was printed on adhesive high-gloss paper using a Canon Ink Blotter and affixed to a blank 18”x18” folding game board.

4.4.3.4 Story Book

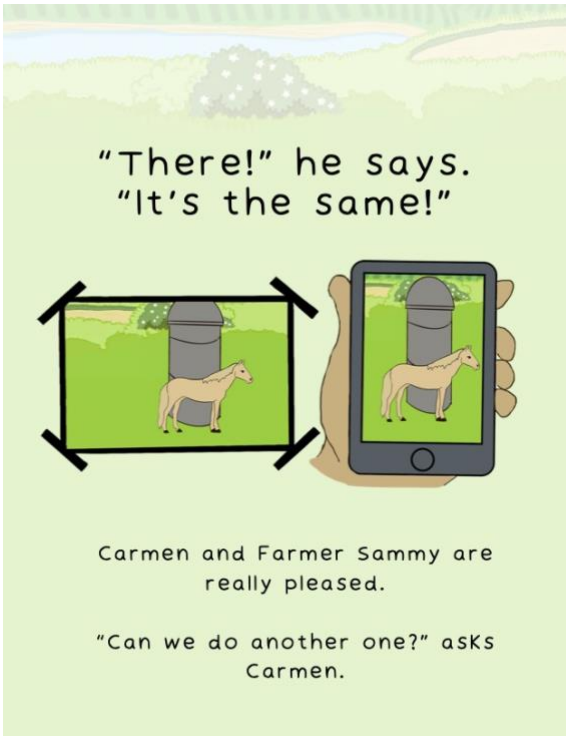
An illustrated storybook, written by the first author and illustrated by a member of the research team, was created to introduce participants to the materials and the task objective. The illustrations were done on an iPad. The book was created on Canva.com™ and printed as an 8.5”x11” soft cover book using Amazon self-publishing service[1]. The companion storybook features illustrations of animals and objects that mirror the game's artifacts, ensuring visual and thematic alignment between the narrative and game. The instructional storybook demonstrates the task objective through a fictional narrative about characters who collaborate to replicate scenes from a photo album. To reinforce the goal of giving and following directions, the

[1] *Bringing Photos to Life: A Companion to Building Relational Vocabulary Together* is available online at https://a.co/d/fP4WstL. A PDF version can be provided upon request by contacting cooper.b@berkeley.edu.

storybook presents side-by-side illustrations that juxtapose the original photographs with the newly recreated scenes (Figure 3). The storybook also serves to draw attention to contrasts between select materials (e.g., dogs with more/less spots); introduce thematic non-relational vocabulary used in the game (e.g., silo, tractor, pig), and model directive statements (e.g., “put the horse next to the silo”).

Figure 3

Sample Story Book Page



Page from Bringing Photos to Life, the companion story book, presenting side-by-side illustrations of the original photographs with the newly recreated scenes

4.4.4 Session format and setting

A total of 14 sessions took place in a semi-private portion of the participants’ school library, which was made available for the duration of the study. Mirroring a typical speech therapy schedule, sessions took place two times a week for five weeks. Each session lasted approximately one hour and took place in a 1-to-1 format with the first author, a licensed SLP, serving as the interventionist. Emily and Diego participated in 9 and 5 sessions, respectively. Some sessions did not take place due to absences and school closures. Diego participated in 5 consecutive sessions but did not continue due to an extended family trip.

4.4.5 Procedures

4.4.5.1 SGD Preparation

Participants used their own SGDs throughout the study. All the participants used popular AAC software with robust vocabularies, including relational vocabulary. Relational words and their representations were pre-existing on each child's SGD. Prior to beginning the first session, the first author searched the SGD for the following non-relational words that were thematically related to the activity: *dog, horse, duck, pig, barn, silo, tractor, wagon, fence,* and *bridge.* Missing words were added. For Emily and Diego, *silo* was the only missing word. It was added under the Places folder. The participants were shown the new icon and how to locate it during the first session.

4.4.5.2 Session Procedures

At the start of the first session, the SLP read the storybook and visually introduced the game materials to demonstrate the correspondence between the game and the narrative. After reading, the SLP instructed participants that—mirroring the characters in the story—they will view a picture on a card and provide directions to the SLP who will arrange the toys on the board so that they match the card. The participant and SLP sat at a table with the board in front of the participant. The game artifacts were placed in the participants' view but out of reach. All the artifacts were on the table, meaning the SLP had more objects than necessary to recreate the model. During the first session only, two practice cards were used along with guiding questions, modeling, and direct instruction to support the participants in expressing information about the card.

At the start of each subsequent session, the participant was verbally reminded of the task objective and was shown the side-by-side images in the storybook as a visual reminder. A card was randomly chosen from the stack of cards, less those previously completed. Without looking at it, the SLP placed the card in a binder and positioned the binder in the participants' field of vision. The binder blocked the SLP's view of the card. The child was reminded that the content of the card is unknown to the SLP who is simply following their directions. The SLP initiated the activity by asking a question that elicited a direction or description of the card (e.g., *tell me what I should get; what do you see?).* Both verbal and non-verbal forms of communication were used to reach common ground (e.g., eye gaze, nods, pointing, giving options, asking questions, moving artifacts). After confirming the child's intention, the researcher recast the child's direction using relevant relational concepts (e.g., *I should get the thinner pig?),* then provided explicit instruction, prompts, and guidance for the child to produce the target relational word(s) on their SGD (e.g., *thin is under 'size and speed'*). After the child produced the target word(s), the SLP praised the child for giving directions and encouraged continuation of the game by asking an open question or requesting details (e.g., *what's next?; should I open the door*?).

Once participants indicated they were satisfied or no longer wanted to give directions, they were encouraged to take a picture of the toys on the board using their iPad. During the *review* phase, the SLP highlighted similarities and deviations between the iPad photo and the card using appropriate relational vocabulary and directive language (e.g., *you could have told me turn it around; you told me to put the dog behind the wagon*). The procedure is repeated with a new card during subsequent sessions.

4.4.6 Data Source

Video-based observations were used to record and study the 14 sessions. Audio and video data was collected using two Canon VIXIA HF R700 Camcorders.

4.4.7 Data Analysis

To segment and analyze the video recordings, a whole-to-part inductive approach to video analysis was employed (Derry et al., 2010). The videos were reviewed multiple times and indexed to identify shorter segments of interactions. Interactions within each session were categorized as a *giving directions* phase or a *review* phase. The *giving directions* phase was characterized by on-task conversation about the activity without the clinician having knowledge of the card. The *review* phase was defined as periods of interaction where the clinician and participant discussed shared information relevant to the task after the SLP had seen the model. Essentially, it involved conversations about the results of the *giving direction* phase. For this study, we focus the analysis on the *giving direction* phase.

Data from the *giving directions* phase was segmented into moves, which were defined as periods of interaction that centered around accomplishing a specific recognizable action that progressed the game. The moves were carried out by the SLP based on successful interpretation of the participants' multimodal direction. Examples of outcomes from moves include selecting target artifacts, and placing, positioning, manipulating, or removing artifacts on the board. A move generally starts with the clinician asking a question or soliciting information about the card (e.g., *what's next; what else; what should I do; which one*). A move is over when (a) the clinician asks a new question which starts the next move (b) the partners decide to enter the review phase, or (3) the interaction goes off task. Moves that centered around one or more relational concepts were further reviewed.

The video excerpts presented in this study were selected using a theory-based sampling approach, which involves selecting cases that represent important constructs regarding a phenomenon of interest (Suri, 2011). Two excerpts were chosen because they provide clear examples of how the BRVT's features may facilitate students' learning of graphic symbols representing relational concepts. The three main design objectives we explore are: (a) establishing mutual understanding (b) integrating sensory and linguistic experience, and (c) supporting self-repair using SGDs. Our analytic approach was informed by micro analysis within in-person interactional AAC research (Higginbotham, 2009) and the Co-Operative Action approach (Goodwin, 2018).

Micro-analysis of in-person interactions explores how elements like spatial orientation and various communication modalities are utilized during real-time exchanges between individuals in AAC-mediated interactions. This approach involves a turn-by-turn and moment-to-moment analysis of participants' actions and responses (Higginbotham, 2009). We predominantly draw upon micro-analysis of in-person interactions in exploring how the activity contributes to mutual understanding (Section 4.5.1) and self-repair using SGD (Section 4.5.3). The co-operative action approach (Goodwin, 2018) offered an additional framework for examining the mechanisms of symbol grounding in the data (Section 4.5.2). The co-operative action approach describes how people systematically use and transform various materials—linguistic, nonlinguistic, and material artifacts—to organize their action and jointly establish situated meaning. The following concepts from the Co-operative Action framework were used as codes to analyze how the activity contributes to the integration of sensory and linguistic input (i.e., Design Objective [b]). According to Goodwin (2018), humans continually engage in *reuse*, which refers to the practice of selectively incorporating elements from prior actions in the

interaction into current actions. This reuse often involves *decomposition*, where specific features of previous actions, such as words, syntax, gesture, prosody, etc., are broken apart to be reworked or repurposed for the current action. Goodwin refers to the repurposing of these semiotic materials as *transformations*, whereby reused elements are not merely repeated but altered to fit the needs of the ongoing interaction. The term *substrate* points to the earlier utterance or action that is being used by another person as the source of transformation to create the next action.

Lamination is the process of layering multiple semiotic materials—such as words, gestures, tone, and objects—together to form what Goodwin calls a *semiotic package*. This package consists of materials with complementary properties, such as words and gestures, that, when combined, create a richer and more effective communicative action. As these semiotic materials are reused and transformed over the course of interaction, they begin to accumulate. This *accumulation*, or sedimentation, refers to the systematic layering of materials into substrates that are repeatedly reworked and built upon in future interactions. Over time, the repeated reuse and transformation of these accumulated semiotic packages allow for the development of mutual intelligibility and the emergence of shared symbols, which carry consensual meaning between participants.

4.5 Results

The three results sections that follow correspond to the interactional processes that we aimed to design for. Section 4.5.1 describes how BRVT responds to Design Objective (a) — establishing mutual understanding — by demonstrating how the shared task objective and material qualities of BRVT facilitate efficiently establishing common ground, which mediates opportunities for conversational recasts. Section 4.5.2 responds to Design Objective (b) — integration of sensory and linguistic experience — by showing how the availability of rich semiotic resources (e.g., gesture, words, symbols, artifacts, movement) create the conditions for grounding the meaning of graphic symbols for relational words in concrete experience. Finally, in Section 4.5.3, we address Design Objective (c) — supports self-repair using SGDs — by showing how the interactional structure and environmental layout of BRVT both elicits and supports self-repair with relational words, thereby increasing instances of production practice.

Each of the three results sections draw upon data from Emily (Excerpt 1) and Diego (Excerpt 2). The excerpts are used to elucidate how BRVT's theoretically informed design objectives were realized through the participants' interactions with the SLP (first author). Excerpt 1 describes Emily's first use of the word *around* within the context of the study, which took place during Session 5. It is the first time that the concept was used by either Emily or the SLP for the purpose of the game. Excerpt 2 presents Diego's first expressive use of the word *short* within the context of the game. This dialogue takes place during Diego's first study session. In Excerpt 2, the dyad is working on the first card following the two practice cards. The full excerpts are presented in Section 4.9.

Transcription Notation Key

↑	increasing pitch	[	overlapping
↓	decreasing pitch	(.)	small pause less than 1/10 of second
:	elongation of preceding sound	(#)	Longer pause duration
(( ))	nonverbal action	> <	speech is faster than surrounding talk
(h)	exhale or laughter	°	Speech is lower volume than surrounding talk
=	connected speech	·hhh	inhale
	Naturally spoken elements are unformatted CAPITAL NON-ITALIC WORDS are louder compared to surrounding talk *CAPITAL AND ITALICIZED* refers to graphic icons not produced as synthesized speech		"*digitized or synthesized speech*" is italicized and in quotation marks <u>Underlined words</u> or syllables are emphasized

Note. The transcription notations were adopted with adaptations from Jefferson (2004) and Von Tetzchner & Basil (2011).

4.5.1 Establishing mutual understanding

In both excerpts, the SLP and participants were able to quickly establish mutual understanding, allowing the SLP to recast the participants' contributions using relational vocabulary and offer the respective graphic symbol as another tool for expressing their intention. Specifically, the collaborative objective and material qualities of the BRVT task provided context and conversational structure that contributed to the SLP's comprehension of the participants' intended message.

Excerpt 1 was taken during Emily's fifth session. Prior to the start of Excerpt 1, Emily indicated the artifacts present in the card by saying "*pig, dog, duck*" on her SGD and established the placement of the pig and dog (see target card in Figure 4b). Excerpt 1 begins with the SLP asking "should we talk about the ducks?" (Excerpt 1 Line 1). Because both partners were aware of the goal to recreate the model on the card, Emily correctly interpreted the SLP's turn as an indirect request for information on how the ducks should be arranged on the board, despite not being overtly asked. Emily responded to this request by making a circular motion in the air (Excerpt 1 Line 4; Figure 4a). Although this circle gesture was potentially ambiguous, the SLP inferred that Emily was providing information about spatial arrangement because it directly followed the SLP's previous turn.

Figure 4.

Circle gesture and target card

(a)

Emily making a circle gesture to provide a direction about the location of the ducks based on the target card.

(b)

Card that Emily was working to recreate in Excerpt 1

Similarly, in Excerpt 2, the SLP and Diego demonstrated that they were reciprocally aware of each other's intention to progress the game, allowing them to easily establish and maintain common ground. In Lines 1-11 of Excerpt 2, the SLP demonstrated how the fence can be extended and contracted (Figure 5). Although the SLP did not explicitly ask a question, the shared objective allowed Diego to correctly anticipate the SLP's intent to solicit a direction. In Line 12, Diego signaled his grasp of the shared goal by glancing at the target card before vocalizing "Shhhuh" (Excerpt 2 Line 15). Although his articulation may have been unclear without context, the SLP recognized Diego's utterance as proactively contributing information about the topic at hand—the fence's length—which substantially constrained the possible interpretations of his vocalization.

The achievement of mutual understanding was further supported by the constraints imposed by the BRVT materials themselves. At the beginning of Excerpt 2, the SLP held the fence at chest level to demonstrate that it could only be expanded or contracted horizontally. Prior to the start of Excerpt 2, Diego confirmed that the tall fence—rather than the short one—was needed and established its placement in front of the horse.

Figure 5.

SLP showing movement of fence, target card

(a)

SLP showing Diego that the fence can be long or short horizontally. Circle displaying tall fence on the short fence on the table.

(b)

Card that Diego was working to recreate in Excerpt 2

With placement already established, the only remaining relevant feature was the fence's horizontal dimension (i.e., long or short). The situational context made Diego's otherwise unclear utterance easy for the SLP to interpret, allowing her to promptly offer a recast in Line 16 ("it should be short?), and another spoken model in Line 24 ("short"). The materiality of the artifacts also reinforced the interpretation of Emily's circle gesture in context because the ducks were 12 individual pieces that afforded being arranged in various configurations—including in a circle.

In Emily's case, the shared objective and material characteristics of the activity allowed the dyad to maintain mutual understanding while they co-constructed a complex direction. In Excerpt 1 Lines 29-32, the SLP asked "you want me to put the ducks in a circle around…which one?" The question "which one," reflected the SLPs inference that the ducks are likely to be arranged around one of the two artifacts on the board given the constraints of space and the previously established placement of the dog and pig. By structuring her turn in this way, the SLP created the condition for Emily to provide the missing information in a way that minimized the likelihood of misunderstanding, regardless of the modality she chose (Clarke & Wilkerson, 2007). In addition, the syntactic structure of the SLPs' turn served to maintain awareness on the pragmatic function of the utterance that they are co-constructing—to generate a direction the SLP will follow. Although the instruction was collaboratively constructed over several turns, Emily and the SLP maintained common ground throughout the interaction, allowing the SLP to

provide progressively longer and more complex recasts with *around* as Emily contributed new information (Excerpt 2 Lines 25, 29-32, 35-38; Figure 6).

Figure 6.

Simplified lines from Excerpt 1 showing progressively more complex recasts

	24	E	"*circle*"
Recast →	25	S	>You want me to put the ducks [in a< ci:rcle?
	28	E	mhmm
Recast →	29-32	S	Wo:::::w(.) ↑ (.) you want me> to put the ducks in a circle< [AROU:::ND(.) which one?
	34	E	*"pig*"
Recast →	35-38	S	[·hhh You want me to put the ducks in a circle AROU:::ND the pig? ↑

Note. Words produced with synthesizes speech output are italicized and in quotation marks.

Both excerpts demonstrated how BRVT accomplished the design objective of efficiently enabling mutual understanding. Two characteristics of the activity that contributed to mutual understanding are the shared objective and material constraints. These characteristics lent themselves to a highly contextualized and structured conversation that maximized common ground and minimized communication breakdowns. Gleaning the participants' intended meaning quickly enabled the SLP to provide precise recasts of their utterances using relational vocabulary with minimal time delay, which likely mediated the effectiveness of the recasts. The efficiency in mutual understanding also increased opportunities for the SLP to incorporate graphic symbols for relational words into the interaction. The integration of graphic symbols representing relational vocabulary is described in the following section.

4.5.2 Integrating sensory and linguistic experience

Integration of sensory experience, spoken language, and aided language is critical for learning the meaning of symbols representing relational concepts, as prior research suggests that children map words onto their perceptual, motor, and environmental experiences (Glenberg & Gallese, 2012) and refine their symbolic understanding through joint activity (Vygotsky, 1978). The data revealed that BRVT created opportunities for this integration by inviting the use of various semiotic materials—including graphic symbols, spoken language, prosody, gesture, and artifacts—to support participants in imbuing graphic symbols representing relational vocabulary with task-relevant meaning. The incorporation of linguistic, multimodal, and environmental resources into communicative actions conjecturally enabled participants to ground, or link, the meaning of graphic symbols representing relational words to their corresponding spoken word and the environmental conditions that the symbol describes. Key concepts from the co-operative action framework (Goodwin, 2018), such as reuse, transformation, and lamination (described in Data Analysis), were adopted to characterize the actions in each excerpt that appear to contribute to symbol grounding.

Except 1 illustrated how the dyad's co-operative actions helped connect Emily's embodied sense of the spatial relationship between the ducks and pig to the graphic symbol

AROUND[2], using gesture as a bridge. In Excerpt 1 Line 4, Emily produced a circle gesture to iconically communicate her visual perception of the spatial relationship (Figure 4a). Emily reinforced the connection between her perception and gesture by spontaneously producing "*circle"*[3] on her SGD (Excerpt 1 Line 24).

The SLP acknowledged Emily's gesture as meaningful through verbal praise and imitation of the gesture (Lines 5-8; Figure 7a). Building on this, the SLP simultaneously checked for understanding and provided a conversational recast (Clark, 2018) by overlapping the iconic circle gesture with the phrase "in a circle," (Excerpt 1 Line 25-27; Figure 7b). By laminating—or layering the circle gesture and the spoken talk of "in a circle," the SLP leveraged Emily's understanding of the *CIRCLE* symbol to concretize the connection between the circle gesture and Emily's visual perception of the spatial relation (Goodwin, 2018). In later turns, the SLP built on this connection to integrate the spoken word *around*[4].

Figure 7.

Changes in the layering of gesture and talk

(a)

5 S [W(h)ow I like how you did that]=
[((makes a circular hand motion))]

(b)

24 E Gasps "*Circle*."
25 S >You want me to put the ducks [in a< ci:rcle]?
[(((circular motion))]
28 E mhmm

(c)

29 S Wo:::::w(.) Emily↑ (.) you want me> to put the ducks in a circle< [AROU:::ND](.)which one?
[((circular hand motion))]
34 E "*Pig*"

(d)

35 S ·hhh you want me to put the ducks in a [circle AROU:::ND] the pig?
[(((circular hand motion))]

Note. Brackets are used to show point of overlap between speech and circular gesture

[2] Capital and italics used to denote reference to a graphic symbol; no synthesized speech.
[3] Italics within quotes is used for synthesized voiced output.
[4] Italics without quotes is used to denote a concept.

In her next turn, the SLP reformulated and expanded Emily's contribution by asking for more information (Lines 29-32). While maintaining much of the prior syntactic and semantic structure, the SLP transformed the utterance by aligning the circle gesture with the relational term "around," which she produced with emphasis and increased volume (Figure 7c). By realigning the gesture from the production of "circle" to the production of "around," the SLP used Emily's gesture as a visual cue for Emily to apply her perceptual sense of the spatial arrangement to the word *around*.

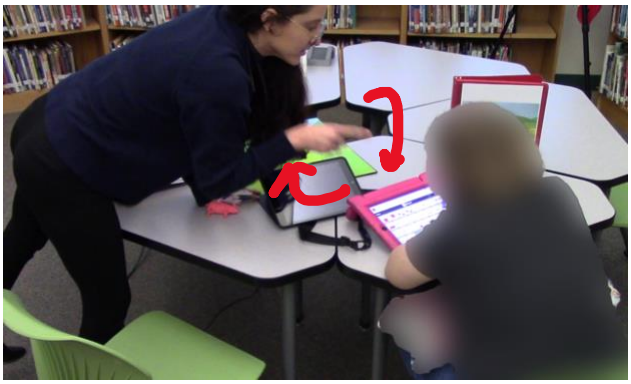
After Emily's contribution of *"pig"* (Excerpt 1 Line 34), the SLP deployed a final recast of the complete direction (Excerpt 1 Line 35-39; Figure 7d). This turn represented an accumulation of resources—such as repeated circle gesture, syntactic structure, word choice, volume, and emphasis—that had been layered and transformed throughout the interaction (Goodwin, 2018). In the final recast, the SLP deployed these accumulated elements, particularly the circle gesture, to strengthen the association between Emily's visual-perceptual experience and the relational term 'around.'

In Lines 47-55 of Excerpt 1, the accumulated resources were leveraged again to explicitly integrate the graphic symbol *AROUND*. After navigating to the *WHERE* folder on Emily's SGD, the SLP said, "here in the where folder, there is around." Once both Emily and the SLP focused their gaze on the symbol, the SLP added, "and it looks like a circle," while producing the circle gesture (Figure 8a). This turn drew on earlier semiotic resources and the symbol's iconicity (Figure 8b) to explicitly connect the *AROUND* the spatial-relational situation in the environment, again using the circle gesture as a key vehicle.

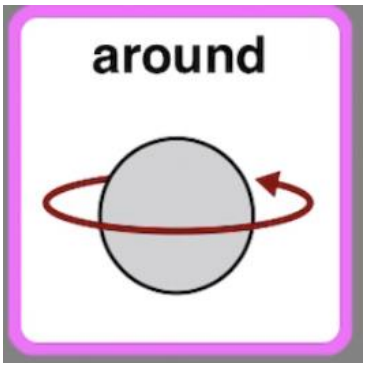
Figure 8.

Using gesture to connect spoken word to graphic symbol AROUND

(a) Lines 47-54 of Excerpt 1



(b)



47	S	[he::re in the w- in the where words= (2.26s) [((start navigating on device)) =there is [A(.)ROU:::ND]= (3.39s) [((gesturing circular motion] points to *AROUND*))
51	E	((looking at device))
52	S	=and it [looks like] a circle [((repeat circle gesture, then palm up))

Screenshot of *AROUND* symbol from Proloquo2Go used by both participants

Like the interaction with Emily, Excerpt 2 showcased how the SLP and Diego made use of embodied and linguistic semiotic resources, including iconic gestures and prosody, to scaffold Diego's use of the polysemous icon *SHORT*. The interaction captured in Excerpt 2 occurred during Diego's first session. The excerpt began with the SLP holding the fence at chest level and showing Diego how it can be expanded and contrasted along its horizontal axis (Figure 9a-b). In addition to providing this perceptual demonstration, she laminated her movements with syntactic and prosodic features that reinforced the meaning of *long* and *short* (Excerpt 2 Lines 1-1). In terms of syntax, she used "or" to combine two structurally alike sentences ("I can make it long or I can make it short"). Prosodically, she raised her pitched and extended the vowel duration in the word "long" to synchronize its articulation with the physical action of expanding the fence. This was contrasted with a short vowel and falling tone on "short" which she temporally aligned with contracting the fence. Brief pauses before "short" and "long" increased the perceptual salience of those words in the stream of speech. By combining resources—syntax, speech, manipulation of artifacts, pitch, and vowel length—the SLP underscored the oppositional nature of *short* and *long* while overtly establishing the relationship between the spoken words and the corresponding visual-perceptual situation (i.e., the length of the fence).

After Diego made it clear that the card shows the fence in the contracted position, the SLP encouraged him to locate the *SHORT* icon (Excerpt 2 Line 25-29 and Line 42). After some wait time, Diego had not located the icon. In Line 42, the SLP said "see if you can find short." She reused the prosodic features from her earlier turn (i.e., falling pitch, short vowel, rapid articulation). By effectively demonstrating the meaning of *short* prosodically, she attempted to provide Diego a semantic clue that might help him locate the symbol. Diego began to navigate to the home button but then shifted his gaze to the SLP who interpreted the behavior as a request for help. In her response, she reused and combined semiotic materials from earlier actions. Her response of "I remember we have tall and short," (Excerpt 2 Lines 47-50) used similar contrastive pitch and timing as earlier, with longer vowel length and raising pitch on "tall" and short vowel length and falling pitch on "short." This created a sense of parallel structure between *long*-and-*short* and *tall*-and-*short*. She laminated her speech with iconic gestures, raising her hand above her head in time with "tall" and lowering it to the floor in time with "short" (Figure 9c-d). This semiotic package (Goodwin, 2018) of speech, syntax, gesture, and prosody is meaningful at this point of the interaction for two reasons: first, the gesture iconically referred to the graphic symbols for *TALL* and *SHORT* on Diego's SGD (Figure 10); second, it directly pointed to gestures used earlier in the session—prior to the start of Excerpt 2— when Diego referred to the tall (versus short) fence. The SLP reused and transformed the arm-up-arm-down gesture in the present action to provide Diego a memory cue for the navigational path. By laminating the old gesture with more recent semiotic resources, including parallel syntax and prosody, she also highlighted the similar yet polysemous meaning of "short" and the *SHORT* icon, which may not be intuitive given its iconic refence to vertical height (von Tetzchner, 2015).

Figure 9

Accumulation of semiotic resources used to construct meaning on SHORT icon

(a)

4 S [This fence↑=
5 [((bring fence to chest level))
6 =I can make it [(.)lo:ng [(1.85s)=
[((extends fence)
7 [((small nod))

8 D

(b)

9 S =[or >I can make it<(.)=
10 [((contracts fence))
11 =short↓

(c)

47 [I remember we have ta:ll=
48 [((brings arm above head

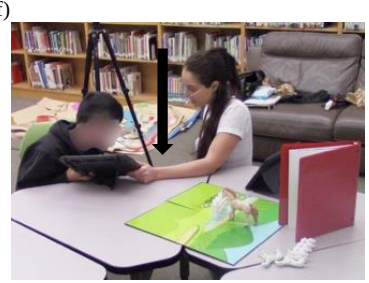
(d)

49 S =[n short… ↓(.71s)=
50 [extends arm down
51 D towards floor))
[((eye gaze follows hand
up then down))

(e)

64 S So this w[as[(1.21s) [ta::ll (.98s)=
65 [((raising arm up))
66 D [((looks at S, follows
arm up))
67 D [((looks
towards
SGD))

(f)

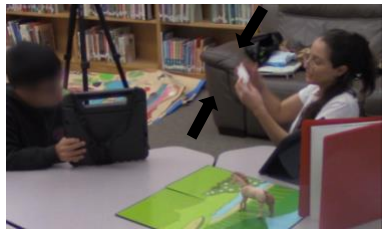


68 S = AND [<u>THIS</u> one is↓
69 [((bringing arm down
towards floor))
70 D ((gaze on SGD and finger by *TALL*))
[Look(.) >look at me< [<u>short°</u>↓
71 S [((looking at D while arm is
72 extended down))
[((looks at
73 D lowered
hand))

(g)

81 S =tall can be [ta:ll and short↑=
82 [((extends arm up
and then
83 S down))
84 =and we can also make it(.)=
85 =[lo:ng=
[((stretches arms out]

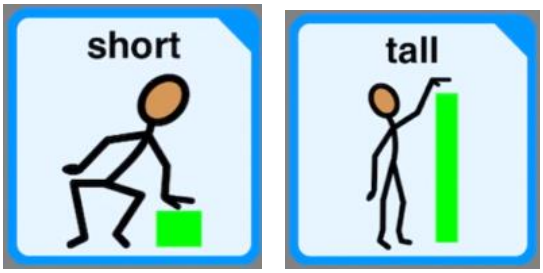
(h)



84 S =a[nd short↓
86 S [Brings hands back
together))

Figure 10

Screenshots from Proloquo2Go used by both participants



After following the SLPs hand with his gaze, Diego initiated the correct navigational path. When he reached the array containing *TALL* and *SHORT*, he said "hmm?" (Excerpt 2 Line 63), which the SLP interpreted as a request for help or more information. In response, the SLP reused and transformed earlier talk and other semiotic resources to support Diego in choosing the symbol that described the relational modifier needed. In the current turn, she said "so this one is tall, and this one is short," (Excerpt 2 Line 64-71; Figure 9e-f). This utterance represented a reuse and transformation of her earlier utterance, "I remember we have tall and short," wherein she maintained the oppositional syntax structure, lamination of contrastive vowel length and pitch on "tall" and "short," and the arm-up-arm-down gesture. However, she transformed the utterance by saying "this one is—." By laminating "this one" with her arm gestures, the SLP made the semiotic connection between her gestures and symbols explicit.

This body-indexing was understood by Diego. After following the SLP's upward hand with his gaze, he quickly moved his gaze and finger towards *TALL*. Before activating *TALL,* the SLP used increased volume, emphasis, and a verbal command ("look at me") to interrupt his unfolding action and call his attention to her hand held towards the floor (Excerpt 2 Line 68-71). Once his gaze was on her lowered hand, she finished her utterance with "short." Diego correctly interpreted the iconic gesture and produced "*short*" on this SGD.

To summarize so far, the dyad used an accumulation of transformation involving syntax, speech, pitch, vowel length, and gesture to integrate the spoken word "short" to its graphic symbol. The dyads took advantage of resources earlier in the conversation and the iconicity of *SHORT* and *TALL* to imbue meaning on the *SHORT* icon. After Diego produced "*short"* on the SGD, the SLP made explicit referent to the polysemous meaning of *short* and, by extension, the multiple relational meanings of the *SHORT* icon by saying "yeah, but in this case—" (Excerpt 2 Line 78; Figure 9g-h). She explained that *SHORT* can be used to contrast with *tall* as well as with *long*. To do this, she once again reused the now familiar semiotic package for *tall* and *short*—arm-up-arm-down gesture, vowel length, and pitch (Excerpt 2: Lines 81-82). She immediately followed this action by extending her arms outward horizontally while saying "long" and brought her hands back together on either side of the fence while saying "short" (Excerpt 2: Line 83-85). The alignment of the outward and inward movement of her arms served to laminate the perceptual experience of horizontal length to the spoken relational words. She also made the dual meaning of *SHORT* salient by reusing contrastive vowel length and pitch to create a parallel structure between *tall*-and-*short* and *long*-and-*short*. Finally, her manipulating the fence in the present turn indexically "pointed to" the manipulation of the fence that she did at the start of the interaction, where Diego initially expressed his relational judgement (Excerpt 2 Line 1-11; Figure 9a-b).

In summary, the BRVT activity created an interactional context where various semiotic resources—such as artifacts, gestures, speech, symbols, pitch, and syntax—were reused, transformed, and layered to integrate graphic symbols with both embodied and environmental experiences, as well as spoken language. Over the course of the interaction, all the available semiotic resources were used to accumulatively build towards a consensual meaning for *AROUND* and *SHORT* that facilitated progress in the game. By embedding these resources and co-operative processes in a joint action activity, BRVT likely facilitated participants' recognition of the graphic symbols as available tools for coordinating actions.

4.5.3 Supporting self-repair using SGDs

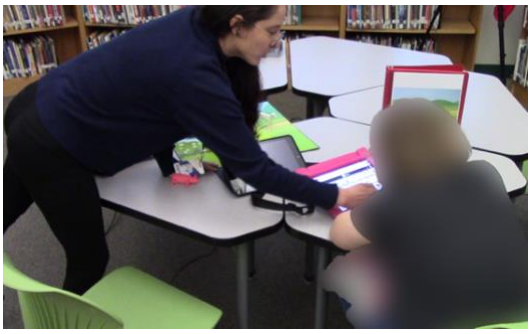
As with other conversation-based interventions, BRVT incorporated strategies to encourage the expansion and repair of utterances, as well as to support the construction of messages on SGDs. Beyond these strategies, the data revealed unique features of BRVT that enabled participants to attend to operational features of their SGDs and effectively self-repair their utterances using relational vocabulary. These features related to the structure of the interaction and the environmental layout of the game. Both excerpts provided examples of how BRVT invited an interactional structure that served to explicitly pivot the conversation's focus towards message construction using the SGD. This interactional structure also facilitated the dyads' reorientation to the joint-action task once the SGD-mediated repair was complete.

In Excerpt 1, after the SLP grasped Emily's intended meaning, she deployed multimodal actions to overtly direct Emily's attention to her SGD. These actions included verbally asking, "can I show you something," lowering the ducks on the game board, moving closer to Emily and leaning over the table towards Emily's SGD (Excerpt 1 Lines 41-46; Figure 11a). With joint attention established on the SGD, the function of the conversation oriented towards the organizational, navigational, and representational characteristics of the *AROUND* symbol and created the opportunity to scaffold Emily's use of the relational word. Specifically, Emily observed the SLP navigate from the *SHAPES* folder containing *CIRCLE* to the folder containing an array of spatial vocabulary. While navigating, the SLP provided information about navigational path, explaining that she was navigating to the *WHERE* words. Once at the array, the SLP pointed to the icon representing *AROUND* and verbally highlighted its resemblance to a circle (described in more detail earlier). Emily selected the icon (Excerpt 1 Line 55) and then proceeded to construct a three-word utterance: "*around circle pig*" (Excerpt 1 Line 56). Line 56 represented self-repair of her direction, which had been co-constructed over several turns. Once the repair was complete, a combination of words, gestures, and changes in proximity were used to reorient the interaction back towards negotiating next steps in the game. Specifically, Emily looked up from her SGD towards the SLP and flips back her hair, signaling completion of her turn (Excerpt 1 Line 58). The SLP praised Emily, moved towards the board, picked up the ducks, and said "I'll do it," clearly expressing her intention to carry out the instruction (Excerpt 1 Lines 59-65; Figure 11b).

Figure 11

Orienting attention to and from negotiating meaning to message construction - Emily

(a)



SLP orienting toward message construction by leaning toward Emily and navigating to *AROUND* on her SGD

(b)

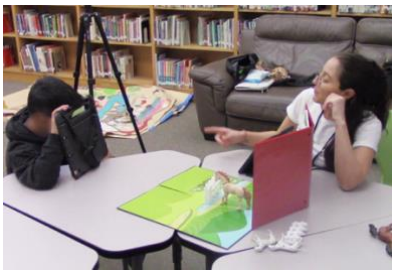
SLP reorienting to the game by moving toward board and picking up ducks to carry out Emily's instruction

Excerpt 2 also provided evidence of an attentional pivot towards message construction using the SGD. After Diego verbally approximated "short," the SLP made evident that she understood the direction that they had co-constructed by praising him and placing the fence on the board in front of the horse. Next, she used a mix of speech, gesture, and positioning to direct his attention to the SGD and encouraged an SGD-mediated repair using *SHORT*. In Excerpt 2 Lines 26-33 (Figure 12a), she pointed to the SGD, asked if he knew how to find the word, and began offering some candidate folders for him to search (i.e., *OPPOSITES*, *SIZE-AND-SPEED*). She reinforced her intention of 'pausing' the game and pivoting to message construction by slightly closing the binder with the target card to block her view before moving closer to him (Excerpt 2 Line 32, Figure 12b). She also reached for the left side of his SGD and straightened it to be aligned with his line of vision. Verbally, she asked to look at his SGD with him (Excerpt 2 Line 35-36).

Figure 12

Orienting attention to and from negotiating meaning to message construction - Diego

(a)



SLP pointing towards SGD

(b)

SLP moving toward Diego and adjusting SGD so they can both see the display

(c)

SLP reorienting conversation back to the activity by opening the book and tapping card with fence

Once joint attention on the SGD was established, the SLP facilitated message construction through prompts, questions, metacognitive cues, and encouragement to locate and activate *SHORT*. The SLP provided verbal information about the icons navigational path while allowing Diego the opportunity to navigate himself. Once he said "*short*" on the SGD, the SLP pivoted the interaction back to the game by explicitly referring to the picture, picking up the fence, and tapping the card with the fence (Excerpt 2 Line 89-91; Figure 12c). By prompting him to confirm a match between the artifact and the image, she situated the interaction around locating *SHORT* within the larger joint-action activity.

Through a combination of words, gestures, and changes in proximity, it became clear to the participants that the SLP's pragmatic intention was no longer to establish understanding, but to bring joint attention to the SGD for the purpose of producing synthesized speech. The focal shift allowed for strategies such as modeling, gestural support, and metacognitive cues to be interpreted as highlighting representational, operational, and organizational characteristics of the target relational word. For Emily, this orientation towards the form of her message created the opportunity for her to spontaneously generate a three-word utterance ("*around circle pig*"). In Diego's case, this pivot took nearly 45 seconds, during which several actions were taken to support Diego in generating the word "*short*" on his SGD (described in detail in Section 4.5.2).

The environmental layout of the BRVT game also supported the participants' ability to practice message construction. During moments focused on constructing SGD-mediated output, the primary game objective—recreating the card arrangement—temporarily paused. However, the game materials remained visually accessible, reducing cognitive load by allowing target concepts to be indexed in the environment rather than relying on memory. For instance, the book with the target card remained within Emily's line of sight, while for Diego, the contracted fence remained visible on the board throughout the interaction. In particular Excerpt 2 demonstrates how the SLP used the fence and card to keep the target concept salient while Diego worked to repair his utterance. Because the game layout remained unchanged, participants easily resumed the activity without needing to depend on memory of prior steps.

In summary, the BRVT activity enabled the participants to self-repair their utterances using graphic symbols for relational vocabulary by clearly pivoting attention from conveying intentions to constructing messages on the SGD. This shift allowed for increased attention on the representational and operational features of the relevant relational word and created a context for scaffolding. The physical nature of BRVT allowed both the relational concepts and the broader conversation to be indexed in the environment, reducing the demands on attention and memory.

4.6 Discussion

The aim of this study was to evaluate the feasibility of a pedagogical tool created to help children expressively use relational vocabulary on their speech-generating devices (SGDs). The findings from this study indicate that the BRVT task—a collaborative, barrier-game style activity featuring purposefully constructed materials—effectively solicits the expression of relational concepts by participants. The BRVT materials were designed to prompt relational judgements through contrasts, such as size and height, movement, and spatial positioning during gameplay. By utilizing a barrier-game format wherein participants had to provide unknown information about a model, BRVT required participants to actively engage with relational language to achieve the shared objective. The findings support the feasibility of BRVT as a tool for teaching relational vocabulary because it creates conditions for using, modeling, and teaching relational vocabulary through natural conversation emerging from the joint-action activity.

BRVT was created with three design objectives, each intended to activate interactional processes that contribute to aided language learning and therefore can support the use of graphic symbols representing relational vocabulary. Rather than assess direct learning outcomes, the purpose of the present study was to investigate if and how the BRVT task accomplished its stated design objectives of (a) efficiently establishing common ground, (b) integrating sensory and linguistic experience, and (c) supporting self-repair using SGDs. By focusing on these three objectives, we aimed to create an activity that mediates opportunities for recasts containing relational vocabulary, grounding of symbol meaning in direct experience, and opportunities for producing relational vocabulary on SGDs.

The findings from this study show support for BRVTs design objectives, suggesting that BRVT facilitates the use of graphic symbols referring to relational vocabulary. First, BRVT's collaborative objective (i.e. recreate a model) and material characteristics (i.e., the toys, board, and cards) brought on constraints that facilitated quick mutual understanding between participants and the SLP (Design Objective A). These constraints fostered a highly contextualized and structured interaction that enhanced common ground and minimized breakdowns. Successfully designing for mutual understanding allowed the SLP to quickly interpret participants' intended meanings, enabling timely, precise recasts of their utterances using relational vocabulary. Additionally, the efficiency of this process created more opportunities for the SLP to incorporate graphic symbols for relational terms into their recasts.

Designing an intervention that streamlines mutual understanding has important implications for aided language teaching because correctly interpreting the meaning of an aided contribution is necessary for providing recasts in conversation-based therapy —an approach that has been supported by research (Cleave et al., 2015; Soto et al., 2020; Soto & Clarke, 2017; Soto & Clarke, 2018). Increased interest in conversation-based therapy and recasts as a teaching strategy stems from a growing orientation in the AAC community towards a sociocultural perspective that language learning emerges through social interactions rooted in culturally mediated practices (Renner, 2002; Von Tetzchner et al., 2018). The present study adopts this

sociocultural perspective while also triggering novel considerations for conversation-based interventions for AAC. Prior research has suggested that the accuracy, noticeability, and frequency of recasts provided via conversation-based intervention may be hindered by characteristics of AAC-mediated conversation that make establishing common ground challenging and time-intensive (Clark et al., 2017; Cooper et al., 2021). The findings from the present study illustrate how interactional and material constraints on conversation — brought on by a shared objective or joint-action —can boost the frequency and saliency of recasts while preserving the motivating and naturalistic qualities of conversation-based therapy.

The second design objective was to create an intervention activity that integrates sensory and linguistic experience concerning relational vocabulary. The integration of direct sensory experience is a necessary component of grounding an abstract symbol's meaning, including those representing relational concepts (Barsalou, 2008; Glenberg & Kaschak, 2002; Harnad, 1990; Piaget, 1952/1936; Wellsby & Pexman, 2014). The data revealed several ways that BRVT brings together sensory and linguistic experience with relational vocabulary. Over the course of the study, participants had the opportunity to manipulate the artifacts and observe the adult manipulating them. Although the task's barrier-game set up intentionally limited the participants' direct manipulation of materials, the game afforded innumerable opportunities to attend to changing environmental cues pertaining to various relationships. By separating the partners' roles—as direction giver and direction follower — BRVT obligated the participants to communicate about relational features in the shared task environment, creating conditions for the affordance of graphic symbols representing relational vocabulary to be realized.

The BRVT task establishes an optimal context for co-operative action, a process through which communication partners imbue meaning on symbols by operating on linguistic and non-linguistic materials, including language, prosody, gesture, artifacts, and proximity (Goodwin, 2018). The co-operative action framework elucidates how BRVT creates conditions for these multimodal resources to serve as a bridge to link embodied perceptual experiences of relational properties in the environment — such as seeing the horse behind the fence —and the corresponding graphic symbol (i.e., behind) on the SGD. In other words, BRVT successfully invites co-operative action, the mechanism with which participants can ground the meaning of graphic symbols representing relational vocabulary in their concrete embodied perception of relevant environmental cues.

Building on Vygotsky's sociocultural learning theory and concept of semiotic mediation, BRVT further contributes to the participants' refinement of symbolic meaning by situating these graphic symbols within a socially mediated interaction (Vygotsky 1978). From a sociocultural perspective, BRVT's adult-child context contributes the construction of symbolic meaning relative to relational words by highlighting relevant environmental cues and scaffolding the child's use of the symbols within purposeful activity (Renner, 2002; Shvarts & Abrahamson, 2023). Moreover, the 'giving directions' element of the BRVT task adds an important dimension to the integration of sensory and linguistic information, and ultimately semiotic mediation. Directing the adult's attention to relevant relational features in the environment is essential for achieving the task objective; however, it is a communication function that children who communicate with AAC tend to have limited experience with (Stadskleiv et al., 2018). Producing directions with graphic symbols representing relational words provides immediate feedback of their success or failure to accomplish the desired outcome, which can lead to further refinement of the symbol's meaning. In this context, the child can attune to the semiotic affordances of using different relational words to effectively communicate their observations and direct the actions of

their partner (Flood et al, 2016). Ultimately, the BRVT task facilitates the integration of sensory and linguistic information (Design Objective [b]) by providing a rich ecology of semiotic resources that create conditions for grounding the meaning of graphic symbols for relational vocabulary in concrete experience. The child-driven, directive nature of the task conjecturally serves to deepen the participants' grasp of relational vocabulary as powerful tools for directing attention to environmental cues and coordinating the actions of others (Borghi et al., 2013).

The BRVT task accomplished Design Objective (c)—eliciting and supporting self-repair of relational vocabulary using SGDs—by leveraging an interactional and environmental structure that orients participants' attention toward message construction while minimizing cognitive demands. Language, gestures, object manipulation, and proximity are used to overtly pivot the interaction's focus, temporarily, from negotiating intent toward message construction on the SGD, encouraging participants to attend to the representational and operational features of relational words on their communication devices. With joint focus on message construction, the instructional intent of strategies such as modeling, metacognitive cues, and organizational guidance can be deployed and attended to (Savolainen, 2024). This interactional structure not only makes the prompt for self-repair evident to the participant (Cooper et al., 2021), but also increases production practice with relational terms, as participants are scaffolded through the process of locating target vocabulary. Additionally, the physical layout of BRVT supports the process of self-repair with relational words by keeping game materials continuously visible. BRVT reduces environmental distractions and reliance on memory by indexing both the relational situation being described and the dyads' progress in the game for as much time as is needed to support the participant. The ability to 'pause' and 'resume' BRVT helps to pivot the learner's attention from meaning to form and back again (Lyster, 2004; Savaldi-Harussi et al., 2019), which enhances opportunities for production practice with relational vocabulary by encouraging and scaffolding self-repair after a recast.

Locating relational vocabulary on grid-based SGDs requires significant attention and memory, as users must navigate to the correct symbols, attend to the ongoing interaction, retain their intended message, and suppress attention to distractors (Sowers & Wilkinson, 2022; Thistle & Wilkinson, 2013; Wilkinson & Hennig, 2009). Extended cognition—a theoretical branch of embodied cognition—suggests that cognitive processes can be distributed across the brain, body, and environment, with external elements, including other people, actively supporting cognitive tasks (Borghi et al., 2013; Clark & Chalmers, 1998; Gallagher, 2013). This perspective helps explain how the BRVT materials and the collaborative actions of the partner help to offload certain cognitive demands related to memory and attention. By externalizing the relational scenario into the materials and sequentializing the social interaction through the partner's step-by-step actions, BRVT distributes cognitive processes across the physical and social environment, allowing participants to focus on message construction without needing to internally track contextual details. Examining BRVT through the lens of extended cognition highlights its potential as a model for enhancing clinical approaches in AAC. Data from BRVT offers a case study in how structured interactions within a richly materialized environment can support relational word learning by distributing cognitive demands across the physical and interactional landscape. This study demonstrates the feasibility of a joint-action activity like BRVT to integrate naturalistic, child-directed conversation with direct instruction, effectively scaffolding the production of relational vocabulary.

4.6.1 Limitations and future research directions

While this study provides valuable insights into the feasibility of the BRVT activity as a tool for teaching relational basic concepts on speech-generating devices, there are several limitations that should be acknowledged, and which offer directions for future research. A key limitation is the study's sample size, including only two participants. In addition, both participants have Down syndrome, are ambulatory, use direct selection, and employ the Proloquo app on an iPad. As a result, the findings may not be generalizable to children with different profiles and communication systems. Future research should replicate this study with a larger and more diverse group of participants. For instance, future research can explore the feasibility of BRVT for teaching the use of relational vocabulary to children with more restrictive motor ability who may have limited communication and motor resources (e.g., pointing, grabbing). In addition, future research can interrogate the application of BRVT to different communication device features, such as motor-plan based programs and visual screen displays.

Second, this study focused exclusively on the "giving directions" phase of the BRVT activity, which involves participants providing unknown information—a context that we found mediates interactional features known to support language learning. However, the BRVT activity also includes a "review phase" that centers on shared information, which may facilitate learning through different mechanisms. Future research should examine how the review phase supports learning compared to the giving directions phase, potentially illuminating the unique affordances of clinical conversations involving shared information versus those that require the aided communicator to provide unknown information.

Our study employed a design-based research (DBR) approach, which presented both advantages and limitations. DBR emphasizes evaluating new tools and interventions within authentic, “real-world” pedagogical contexts (Bakker, 2018). Reflecting this approach, our study was designed to replicate a naturalistic clinical interaction between a student and an SLP. The flexibility of DBR allowed us to adopt a semi-structured protocol while making deviations to explore unexpected outcomes, trial design modifications, remove barriers to students’ ability to express their intentions, and gain deeper insights into their learning (Abrahamson, 2009; Ginsburg, 1997). While this adaptability yielded rich insights, future research may benefit from stricter adherence to a consistent protocol across multiple participants to more reliably assess the intervention's impact on relational word learning.

Finally, while this study focused on qualitative analysis of the interactional processes within the BRVT activity, it did not establish outcome measures for learning. This limits our ability to make claims about actual behavior change or learning outcomes resulting from the intervention. Future research should aim to include both qualitative and quantitative outcome measures to evaluate changes in participant’s use of relational vocabulary as a result of the intervention. A multiple baseline design with a larger number of participants would be ideal for assessing BRVTs impact on relational vocabulary use.

4.7 Conclusions

The present study explored the feasibility of a novel education tool called Building Relational Vocabulary Together (BRVT) that aimed to teach children to expressively use relational vocabulary on their speech-generating devices. The findings demonstrated that BRVT effectively achieved its three design objectives, as related to relational vocabulary: (a) establishing mutual understanding, (b) integrating sensory and linguistic experience, and (c) supporting self-repair. The goal-oriented and collaborative structure of the task, combined with its purposefully designed materials, created constraints that efficiently fostered mutual

understanding between participants and the SLP, allowing for timely and precise conversational recasts that emphasized relational vocabulary. The task integrated sensory and linguistic experiences by using multimodal resources like speech, gestures, eye gaze, and artifacts, helping participants ground the meaning of graphic symbols for relational vocabulary in their concrete, embodied perception of relevant environmental cues. Additionally, the BRVT task elicited and supported self-repair of relational vocabulary using SGDs through an interactional and environmental structure that oriented participants' attention toward message construction while minimizing cognitive demands.

Together, these findings underscored the potential of BRVT to mediate interactional processes critical for learning relational vocabulary on SGDs. By situating relational vocabulary learning in a joint-action task, BRVT created a motivating and purposeful context that balanced naturalistic child-directed communication with structured opportunities for instruction, modeling, recasts, and production practice. These results supported the feasibility of using BRVT as an effective and innovative approach for teaching relational vocabulary in SGD-mediated interventions, contributing to both theoretical advancements and practical applications in the field of aided communication.

4.8 Chapter 4 References

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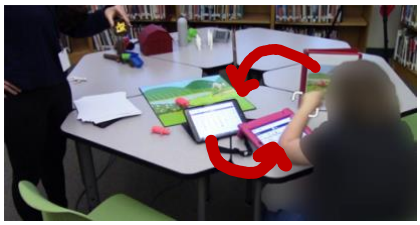
4.9 Excerpt 1 (Emily) and Excerpt 2 (Diego)

Excerpt 1



1	S	So no:w, should we talk about the ducks?
2	S	((picks up wagon containing the ducks))
3	E	((looks at picture, taps chin with index finger))
4	E	((does circular motion with hand while looking at device))
5	S	[W(h)ow I like how you did that=
6	S	[((makes a circular hand motion))
7	S	=Emily[5]↓ that- you- s- I see you do that=
8	S	((continues making a circular hand motion))
9	E	((looking at R))
10	S	=hmm(.) I want you to tell me=
11	S	=[WHERE to put the ducks=
12	S	[((points to board))
13	E	[((looks at picture))
14	S	=so↓(.)you must have to go to your=
15	S	=whe:re [words(4.25s)
16	E	[((looks to SGD selects *HOME*, selects *THINGS*))
17	S	((standing looking at SGD)) Mm, try- go back-
18	E	((shakes hand))
19	E	whoa [whoa whoa ↓ ((selects *SUPPLIES*))
20	S	[>Okay, okay=
21	S	=I'll wait,< I'll wait, I'll wait ↓ (5.07s)
22	E	((Selects *SHAPES*)) ((rubs forehead))
23	S	You're doing great
24	E	Gasps "*Circle*."
25	S	>You want me to put the ducks [in a< ci:rcle?
26	S	[((gesturing=

[5] Changed to pseudonym

27 S =circular motion))

28 E mhmm

29 S Wo:::::w(.) Emily ↑ (.) you want me> to=

30 S =put the ducks in a circle< [AROU:::ND(.)=

31 S [((circular hand motion))

32 S =which one? (5.37s)

33 E ((looks down to device, adjusts leg position))

34 E "*Pig*"

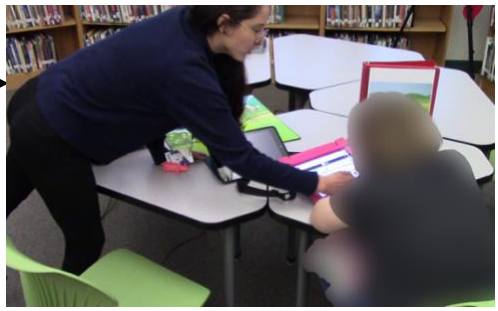
35 S [·hhh You want me to put the ducks in a=

36 S [((moving index finger left to right))

37 E [((shifts gaze to S, leans back then forward in chair))

38 S =[circle AROU:::ND the pig? ↑

39 S [((circular hand motion))



40 E ((shifts gaze from S to her arm)) mhm

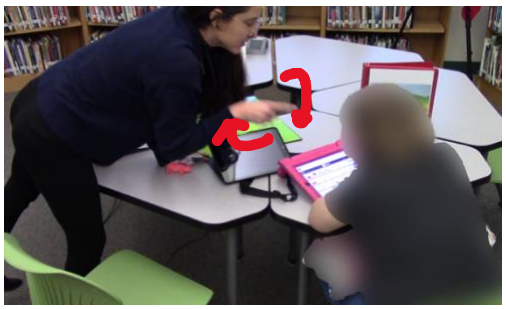
41 S ·hhh [amazing(.)ama:zing(.) Can I=

42 S =show you something ↑↑

43 S ((places wagon of ducks on board))

44 E [((touches forehead and then rapidly=

45 E =moves fingers away))



46 S ·hhh ((leans towards E and touches device))

47 S [he::re in the w- in the where words= (2.26s)

48 S [((start navigating on device))

49 S =there is [A(.)ROU:::ND= (3.39s)

50 S [((gesturing circular motion then points to *AROUND*)

51 E ((looking at device))

52 S =and it [looks like] a circle

53 S ((repeat circle gesture, then palm up))

54 E ["*Around*."]

55 E ["*Circle*." "*Pig*." "*Around circle pig*."]

56 E [(7.73s)]

57 E ((moves hair))

58 S [Arou:nd(.)circle(.)pig (.) >You put that sentence=

58 S =together by< yourse:lf Ka::te=

60 S [((claps, moves away to stand, waves arms))

61 E ((touches glasses and forehead))

62 S =Fantastic (.) ·hhh I'm gonna do it=

63 S ((pours ducks into hand, looks at P))

64 S =Um how many ducks?

Excerpt 2

1	S	[Now let me [show you something(.)=
2	S	[((reaching for fence))
3	D	[((stands device up))
4	S	=[This fence↑=
5	S	[((bring fence to chest level))
6	S	=I can make it [(.)lo:ng [(1.85s)=
7	S	[((extends fence)) →
8	D	[((small nod))
9	S	=[or >I can make it<(.)=
10	S	[((contracts fence))
11	S	=short↓
12	D	((looks at picture then S))
13	S	[You [want t-
14	S	[((begins to move fence towards D))
15	D	[Shhhuh ↓
16	S	It should be short?↑=
17	S	=[I saw you [look at the picture .hhh=
18	S	[((points to picture while nodding))
19	D	[((brings device onto the table
20	S	=Diego[6](.)perfect=
21	S	=You looked at the [picture. (1.46s)
22	D	[((brings top of device to forehead))
23	S	((places fence on board))
24	S	Sh:ort.↓(2.69s)=
25	S	=I [bet that's- you know how to=
26	S	[((point towards device)) →
27	S	=find [short in you::r:↓[thing ↑=

[6] Changed to pseudonym

28 D [((moves device away from head

29 D [((looks at device, [puts side of head on table))

30 S =I think it's under size n:- it might be↑↑ under=

31 S =opposites:[↓ or: maybe it's °under=

32 S [((closes book))

33 S =size n speed° (2.83s)

34 D ((touching strap with device up and head down)

35 S Can we look together?↑

36 S ((moves towards D, reaching towards device))

37 D ee.yeah

38 S ((turns device so both can see; leans toward D))

39 S ((seeing that he's on *HOME-2* Page))

40 D [Mhm. Yeah ↑ [Go ahead go ahead ↑

41 S [((nods)) [((Pats D's shoulder))

42 S >See if you can find ↑< short↓

43 S ((adjusts display))

44 D ((lifts head, looks at S))

45 D ((selects *HOME*; looks at S))

46 S You ↑ try ((brings hand to lap))

47 S [I remember we have tall=

48 S [((brings arm above head

49 S =[n short… ↓(.71s)=

50 S [extends arm down towards floor))

51 D [((eye gaze follows hand up then down))

52 S =that was [under::: ↓(5.86s)

53 D [((selects *DESCRIBING*, then *MORE*))

54 S [Mhm↑((nod)) where do you think?

55 D [((looks at S)

56 D ((looks at SGD))

57 D ((moves finger towards *SIZE AND SPEED* folder))

58 S Yeah, size n speed because it- it's talking=

59 S =about a si:ze

60 D ((selects *SIZE AND SPEED*))

61 S And then(.)do you see short↑?

62 S/D ((both looking at SGD))

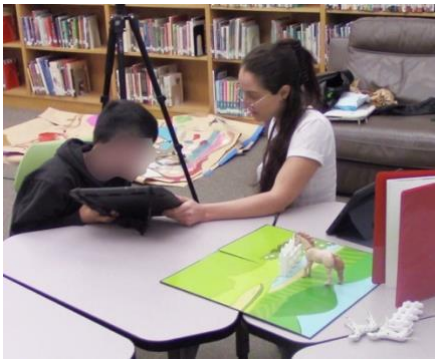
63 D ((moved head to center of SGD)) hmm?↑

64 S So this w[as[(1.21s) [ta::ll (.98s)=

65 S [((raising arm up))

66 D [((looks at S, follows arm up))

67 D [((looks towards SGD))



68 S = AND [THIS one is↓

69 S [((bringing arm down towards floor))

70 D ((maintaining gaze on SGD and finger by *TALL*))

71 S [Look(.) >look at me< [short°↓

72 S [((looking at D while arm is extended down))

73 D [((looks at lowered hand))

74 D ((looks at SGD, moves finger toward *SHORT*))

75 D ((looks back at S))

76 S ((smiles, opens eyes, quick nod)) Yeah°(.)

77 D "*Short*"

78 S Yeah(.)bu- [but in thi:s case↑=

79 S [((releases SGD, turns to board))

80 S ((grabs fence))

81 S =tall can be [ta:ll and short↑=

82 S [((extends arm up and then down))

83 S =and we can also make it(.)=

84 S =[lo:ng] a[nd short↓

85 S [((stretches arms out]

86	S	[Brings hands back together))
87	S	[but, so it's short?(.)
88	S	[((holding fence at chest level))
89	D	((looking at S, lifts chin slightly))
90	S	In [the picture it looks short?
91	S	[((opens book to display picture))
92	S	((taps fence on picture)) ⟶
93	D	((places device down on table))
94	D	((nods, smiles, makes thumbs up))
95	S	((places fence on board))
96	S	Gr:eat↑
		From 1:30-1:45 difficulty getting the pieces to stand. Comments on the quality of the pieces. Not included. (34.73s)
97	S	Oka:y and his head is [up
98	S	[((moves horse head up))

5. Concluding remarks

This dissertation advanced an action-oriented paradigm for AAC intervention by foregrounding the teaching of relational vocabulary within contexts that emphasized interaction, joint-action, and sensorimotor experience. The three studies addressed critical gaps in AAC research and practice, offering both theoretical contributions and practical innovations. Chapter 2 identified relational vocabulary as essential for engaging in joint-action, emphasizing its role in enabling AAC to be used as a tool for action and doing. This chapter provided a conceptual framework and practical resources for vocabulary selection, advancing the theoretical foundations of AAC intervention. Chapter 3 focused on conversational recasts and self-repair using SGDs, positioning children as active agents in their language development. By advocating for explicit prompts to encourage self-repair, it expanded the potential of conversation-based interventions to facilitate linguistic and operational learning in meaningful, interactive contexts. Chapter 4 introduced BRVT, a theoretically informed teaching tool, demonstrating how situating clinical instruction within joint action—foregrounding sensorimotor experience and social interaction—created conditions for establishing mutual understanding, grounding linguistic symbols in concrete experience, and fostering self-repair.

Together, these studies contributed to an AAC intervention paradigm that reconceptualized aided language as a means for doing, making joint-action and situated interaction central to language teaching. This dissertation bridged theory and practice by addressing the gap in relational vocabulary instruction and integrating embodied cognition, sociocultural learning, and language acquisition research into AAC intervention design. This perspective redefined intervention design to better leverage the social context, the body, and the environment in language development. Future research could continue to explore how action-oriented approaches, such as BRVT, expand opportunities for children to engage meaningfully with their environments, direct others' actions, and achieve greater autonomy. Ultimately, this dissertation supported a paradigm shift in AAC intervention design, positioning language as a pragmatic system grounded in action—a perspective that held significant promise for advancing both theory and practice in the field.