Assessing Intentional Communication in Typically Developing Infants Using the Communication Complexity Scale

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A thesis

submitted in partial fulfillment of the

requirements for the degree of

Master of Science

University of Washington

2014

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Program Authorized to Offer Degree:

Speech and Hearing Sciences

University of Washington

Abstract

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The Communication Complexity Scale (CCS; Brady, Fleming, Thiemann-Borque, Olswang, Dowden, Saunders, & Marquis, 2012) is a criterion-referenced assessment of early, primarily pre-linguistic, communication signals. It produces an expressive communication summary score, based on the most sophisticated communication behaviors demonstrated by an individual. According to the authors, this score identifies whether an individual is communicating at the preintentional or intentional level. To date, the CCS has been used to document the communication level of individuals with severe impairments at a variety of ages. However it has not yet been used to document communication levels in typically developing children, an important step in establishing construct validity for the tool. This research project examined whether the CCS is

sensitive to the transition from preintentional to intentional communication in typically developing infants seen at 7 months and again at 11 months of age. According to the current literature, the transition can be expected to occur sometime between these ages. The CCS was used to assess a convenience sample of infants at 7 and 11 months of age. A Wilcoxon signed-rank test revealed non-significant differences between the 7- and 11- month groups. This study did not demonstrate construct validity for the CCS.

Background

Transition to Intentional Communication

The transition from preintentional to intentional communication has been well researched and documented by many leading researchers investigating child language development (e.g., Bakeman & Adamson, 1984; Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979; Mundy, Card, & Fox, 2000; Mundy, Block, Delgado, Pomares, & Van Hecke, 2007; Proctor & Murnyack, 1995; Tomasello, 1995; Tomasello, 1999). Several studies, which will be overviewed briefly, have been conducted with typically developing children to describe the cognitive foundations for intentional communication and the development of joint attention as an indicator of intentionality. Additional research, which will be described in detail below, has been done to examine the typical developmental timeline for this transition. Researchers have found that the development of social cognition and joint attention contribute to the emergence of intentional communication at approximately nine months of age.

Recent research in the area of child language development has focused on the development of social cognition as one of the cognitive foundations of intentional communication. Social cognition is a child's understanding of his own sensory-motor intentionality (or his ability to control his behaviors to achieve a result) and the intentionality of others (Carpenter, Nagell, & Tomasello, 1998; Mundy et al., 2007; Tomasello, 1999). As children develop this cognitive process, they begin to use behavior intentionally to communicate. Initially, they rely on joint attention, a shared focus with an adult, as a context for communication (Bakeman & Adamson, 1984; Mundy et al., 2007; Paparella and Kasari, 2004). One manifestation of coordinated joint attention is a behavior termed triadic gaze (TG; Bakeman & Adamson, 1984; Trevarthan & Hubley,

1978). In TG, the child uses a three-point gaze shift to connect an adult with an object or event of interest. For example, a child may look from a caregiver to a toy and then back to the caregiver, thus connecting the adult to the desired toy and communicating interest in the toy. This observable behavior indicates the development of coordinated joint attention and, according to many researchers, the shift from preintentional to intentional communication (Beuker, Rommelse, Donders, & Buitelaar, 2013; Mundy & Newell, 2007; Mundy, Sigman, & Kasari, 1990).

Additional research has studied the developmental transition from preintentional to intentional communication. In his work, Tomasello identified nine months as the typical age for this transition, which he referred to as the "9-month revolution" (Tomasello, 1999, p. 63). Infants younger than nine months of age engage in dyadic interactions (i.e., gaze or attention to an object or a person) by grasping and manipulating objects or engaging in turn-taking sequences with other individuals. Between nine and 12 months of age, however, children "begin to engage in interactions that are triadic in the sense that they involve the referential triangle of child, adult, and some outside entity to which they share attention" (Tomasello, 1999, p. 64). In other words, typically developing children develop the ability to share focus, or engage in coordinated joint attention, with the people around them, using behaviors such as TG, around nine months of age. Table 1 provides a detailed examination of research regarding the emergence of coordinated joint attention. The data varies according to the ages of the infants studied and the structure of the research tasks. A detailed review of these studies follows, covering the methods and results that are relevant to this literature review.

Carpenter et al. (1998) studied social cognition and joint attention in 24 infants between nine and 15 months of age. Two studies are reported on in this article; the one that is relevant to

this review examined the emergence and development of social cognitive and joint attentional skills. During each of seven monthly visits, the researchers collected data on five social cognitive skills, which were elicited through a series of structured tasks. The five skills and the requisite behaviors included: 1) joint engagement, defined as a three-point gaze shift (i.e., TG) between an object, the experimenter, and the back to that same object; 2) attention following, defined as gaze-following and point-following; 3) imitative learning: defined as an infant's ability to reproduce tasks modeled by the experimenter; 4) communicative gestures, defined as a) declarative gestures (e.g., showing, giving, pointing) while "vocalizing as if to comment," (Carpenter et al., 1998, p. 43) and alternating gaze between the experimenter and an object or b) imperative gestures (e.g., reaching and pointing while vocalizing and alternating gaze between the experimenter and an object); and 5) referential language, defined as words used for concrete objects or actions (Carpenter et al., 1998). The researchers determined the age of emergence (AOE) of each behavior for each participant, defined as the age of the first occurrence of the behavior. They then averaged the AOE across all participants to calculate the group mean AOE for each behavior. Results for mean AOE for each skill were as follows: joint engagement = 9.0 months (no SD reported); communicative gestures = 10.3 months (SD = 1.4); attention following = 11.5 months (SD = 1.6); imitative learning = 11.9 months (SD = 1.8); and referential language = after 15 months (Carpenter et al., 1998). These finding supports Tomasello's conclusion (Tomasello, 1995) that intentional communication begins to emerge around nine months of age; however, all infants in this study demonstrated TG at nine months of age, the earliest age included in the study (Carpenter et al., 1998). Therefore, it is unclear whether a younger AOE would have been found if younger participants had been included in the study. Overall, Carpenter et al. (1998) indicated that

infants begin to develop intentional communication, observed through TG, at or before nine months of age and then progress develop additional social cognitive and joint attentional skills.

Mundy and colleagues (2007) examined the development of intentional communication in 95 infants between nine and 18 months of age. The researchers measured infant performance using the structured Early Social Communication Scales (ESCS; Mundy et al., 2003). The four behaviors examined were: 1) initiating joint attention, defined as use of eye contact to spontaneously share experiences; 2) responding to joint attention, defined as gaze- and gesture-following; 3) initiating behavior requests, defined as the use of gaze and gestures to request aid from a social partner; and 4) responding to behavior requests, defined as the ability to respond to a verbal and gestural request for a specific object. This research study found that all behaviors were present at all ages and that infant performance increased in a linear manner between nine-18 months of age for three of the four behaviors (responding to joint attention, initiating behavior requests, and responding to behavior requests). As in the Carpenter (1998) study, this study found that behaviors indicating intentional communication, such as initiating behavior requests, emerge at or before nine of age, with increasingly complex forms developing as infants grow.

Bakeman and Adamson (1984) observed 28 infants between six and 18 months of age in unstructured play with their mothers and peers. They examined the ability of infants to coordinate attention between social partners and objects when the infants were 6, 9, 12, 15, and 18 months of age. Specifically, they examined the development of five infant states: 1) person engagement, during which the infant is engaged with just the social partner; 2) object engagement, during which the infant is engaged with just the toys; 3) onlooking, during which the infant is

observing another person's behavior but not participating; 4) passive joint engagement, during which the infant and social partner are participating in the same activity, but the infant does not demonstrate awareness of the partner's involvement; and 5) coordinated joint engagement, during which the infant is actively engaged with both the social partner and the toy. Results indicated that infants spent the same amount of time in object engagement across the ages examined, while they spent gradually less time in onlooking and person engagement states, and increasingly more time in passive and coordinated joint engagement (Bakeman & Adamson, 1984). At six months of age the overall percentage of time spent in coordinated joint engagement, the only intentional communication state, was 2.3% when infants were with their mothers and .3% when with peers. This indicates that coordinated joint engagement was emerging for some infants at six months of age and that it occurred more frequently with a familiar communication partner. The percentage of time spent in coordinated joint engagement slowly increased between nine (2.0% with mothers and 1.7% with peers) and 12 months (3.6% with mothers and 1.8% with peers), but showed a large increase at 15 (11.2% with mothers and 4.2% with peers) and 18 months (26.6% with mothers and 7.2% with peers; Bakeman & Adamson, 1984). These findings suggest that infants may begin to demonstrate spontaneous coordinated joint attention as early as six months of age and that they spend increasingly more time engaged in intentional communication with age. This supports the results found by Carpenter et al. (1998) and Mundy et al. (2007) and adds information regarding intentional communication in infants younger than nine months of age.

Beuker and colleagues (2013) have also examined the development of intentional communication in typically developing infants. These researchers assessed joint attention and langu-

age development in 23 infants between ages eight and 24 months. Their research focused on four early communication skills: 1) checking behavior, the infant looking at an adult without sharing attention (i.e., dyadic interactions); 2) sharing attention, the infant alternating gaze from an adult to an object and back to the adult (i.e., TG); 3) following attention, the infant following a gaze or pointing gesture; and 4) directing attention, the infant attempting to direct the adult to a object by pointing, giving, showing, or producing referential words, with or without gaze alternation (Beuker et al., 2013). The skills were examined using tasks that were either structured (following attention, directing attention) or unstructured (checking behavior, sharing attention). This study found that all behaviors developed between eight and 15 months of age. Specifically, checking behavior developed at a mean age of 8.09 months (SD = .29), sharing attention developed at a mean age of 8.48 months (SD = .67), following attention developed at a mean age of 10.3 months (SD = 2.01), directing attention without gaze alternation developed at a mean age of 8.4 months (SD = .59), and directing attention with gaze alternation developed at a mean age of 11.5 months (SD = 2.27). The latest-developing skill was referential language (a component of directing attention), which developed at a mean age of 16.9 months (SD = 2.46) (Beuker et al., 2013). This research suggests that intentional communication, indicated by TG or sharing attention, begins to emerge during the eighth month of life. As with the Carpenter study, however, it is not clear whether this mean age would have been lower if younger infants had been included in the study.

Table 1:

Summary of Research Literature on the Emergence of Intentional Communication						
Researchers	**# of Participants**	**Ages Studied**	**Behaviors Studied**	**Task Structure**	**Relevant Results**	**Age Identified for Emergence of Intentional Communication**
Carpenter, Nagell, Tomasello, Butterworth, & Moore, 1998	24	9-15 months	**Joint Engagement**, Attention Following, Imitative Learning, Communicative Gestures, Referential Language	Elicited in a series of structured tasks	**Joint Engagement AOE: 9.0 months;** Communicative Gestures AOE: 10.3 months; Attention Following AOE: 11.5 months; Imitative Learning AOE: 11.9 months; Referential Language AOE: after 15 months All infants exhibited at least one **Joint Engagement episode** at 9 months of age	9.0 months or earlier
Mundy, Block, Delgado, Pomares, & Van Hecke, 2007	95	9-18 months	Initiating Joint Attention (IJA), Responding to Joint Attention (RJA), **Initiating Behavior Requests (IBR),** Responding to Behavior Requests (RBR)	Structured elicitation using the Early Social Communication Scales (Mundy et al., 2003)	IJA, RJA, **IBR**, and RBR were present at all ages between **9-18 months** RJA, **IBR,** and RBR increased linearly with age between 9-18 months	9.0 months or earlier
Bakeman & Adamson, 1984	28	6-18 months	Personal Engagement; Object Engagement; Onlooking, Passive Joint Engagement; C**oordinated Joint Engagement**	Observations of free play with mother and peers	**Coordinated Joint Engagement began to emerge around 6 months of age;** it increased with age and occurred more frequently with familiar communication partners	6.0 months

Summary of Research Literature on the Emergence of Intentional Communication						
Researchers	**# of Participants**	**Ages Studied**	**Behaviors Studied**	**Task Structure**	**Relevant Results**	**Age Identified for Emergence of Intentional Communication**
Beuker, Rommelse, Donders, & Buitelaar, 2013	23	8-24 months	Checking Behavior; **Sharing Attention**; Following Attention; Directing Attention	Structured Tasks: Following Attention, Directing Attention Free Play: Checking Behavior; **Sharing Attention**	All behaviors developed between 8-15 months of age **Sharing Attention**: developed at a mean age of 8.48 months (SD = .67)	8.48 months

Overall, the results of these studies indicate the emergence of joint attention between eight and nine months of age, with increasing use and proficiency with age. Researchers who elicited behavior using structured tasks examined infants between eight and 24 months of age (Carpenter et al., 1998; Mundy et al., 2007; Beuker et al., 2013). They found that the most advanced communicators were using intentional communication at eight months of age. However, across studies, no elicitation tasks were performed with infants younger than eight months of age. Therefore, the earliest age at which intentional communication emerges in a structured elicitation context remains unknown. In contrast, infants as young as six months were studied in free play (Bakeman & Adamson, 1984). At this early age, these infants showed intentional communication behaviors, although they were infrequent. When examined again at 9, 12, 15, and 18 months, these same infants demonstrated increases in intentional communication (Bakeman & Adamson, 1984). This indicates that spontaneous coordinated joint attention in unstructured contexts begins

texts begins to emerge in some infants as early as six months of age and continues to develop as infants grow.

Development Across Domains

The development of intentional communication during infancy is supported by simultaneous development occurring in other domains. Infant development across motor, sensory, cognitive, communicative and social domains is interrelated and advancements in one domain support and rely on advancements in other domains (Davis, 2013). For example, the ability to communicate through gaze relies on adequate head and neck control, as it is imperative for the communication partner to see the eyes and the gaze behaviors. In addition, the ability to communicate using reaching behaviors requires stable posture and trunk control to avoid falling or instability during the reach.

At nine months of age, typically developing infants can sit without support and maintain an upright head and neck position. They can reach for and grasp toys and objects that may be used in play, and are beginning to develop more refined ability to manipulate them. Additionally, in the social domain, infants can recognize caregivers and can produce social facial expressions, such as smiling (Davis, 2013). These developments allow the infant to explore the environment and interact with objects and people, both of which support the development of intentional communication during infancy.

Children with Disabilities

While many children develop intentional communication within Tomasello's established timeline, children with disabilities, including those with autism spectrum disorder, severe physical impairments, and intellectual impairments, often do not (Iacono, Carter, & Hook, 1998; Papa-

rella, Goods, Freeman, & Kasari, 2011; Olswang, Feuerstein, Pinder, & Dowden, 2013). Some of these children experience delays or disruptions in communicative development, along with delays in other domains, and they transition from preintentional to intentional communication later than expected. Fragile health and unconventional communication behaviors may impede early infant-caregiver interactions. Caregivers may struggle to recognize and interpret communicative signals. It is therefore challenging for caregivers to respond to communicative attempts, resulting in what Halle, Brady, and Drasgow (2004) term communication breakdowns. These breakdowns limit the amount of communication in object and social play (Halle, Brady, & Drasgow, 2004; Arens, Cress, & Marvin, 2005; Paparella & Kasari, 2004; Olswang, Pinder, & Hanson, 2006).

Such challenges are seen in children with a variety of developmental delays, for example children with severe physical impairments and children with social impairments. Children with severe physical impairments, including those with cerebral palsy and Rett syndrome, experience delays in the development of joint attention and social interaction (Iacono et al., 1998; Olswang et al., 2013). These delays result in part from abnormal muscle tone and significant motor limitations. These children may demonstrate impaired ability to manipulate objects, maintain an upright head and neck posture, and sit independently. As a result, conventional communication behaviors, such as gaze and reach, may be compromised, leading instead to the use of unconventional communication behaviors (Sigafoos & Mirenda, 2002). Such atypical communication behaviors may be challenging for caregivers to recognize. This decreases caregiver response to and encouragement of a child's communication and interrupts typical infant-caregiver interactions. (Halle et al., 2004; Olswang et al., 2006; Paprella & Kasari, 2004; Pinder, Olswang, & Coggins, 1993; Olswang et al., 2013).

Another example of delayed development of intentional communication is found in infants with social impairments, such as autism spectrum disorder (ASD). Children with ASD experience delays of intentional communication that are likely the result of underlying delays in the development of social cognition. As reviewed in Mundy's research, this is a foundational skill for intentional communication (Mundy et al., 2007). These delays in the cognitive domain are manifested in the communicative domain through significant impairments and delays in the development of joint attention (Paparella et al., 2011). As with children with severe physical impairments, caregivers may struggle to interpret and respond to atypical communication behaviors in children with social impairments. This can increase the number of communication breakdowns and decrease the amount of communication a child is engaged in during play. In infants with disabilities, delays in the development of intentional communication and joint attention can negatively impact their interactions with caregivers, resulting in frequent communication breakdowns and further delaying additional development in speech and language (Halle et al., 2004) as well as social development and early learning (Iacono et al., 1998).

Current Assessment Tools

The negative ramifications of delays in intentional communication highlight the need for assessments that indicate whether a child is communicating at the preintentional or intentional level. Such tools allow professionals to determine a child's current communicative level in order to effectively plan and implement treatment because early intervention services should be designed "to match a child's current and emerging developmental profile" (Greenslade, Olswang, Weaver, Dowden, Feuerstein, & Pinder, in editing, p. 12). Despite the need for such tools, many current assessments do not provide this information. Existing assessments examine child lan-

guage through parent report, language subtests of developmental batteries, and behavioral language measures. Each of these measures has unique strengths and purposes, as will be discussed below, but most do not thoroughly document the transition from preintentional to intentional communication.

Several tools used by SLPs to assess early communication skills rely on reports from the caregiver or other observers. These include the MacArthur-Bates Communicative Development Inventories (CDI; Fenson, Dale, Reznick, Bates, Thal, & Pethick, 1994), the Communication and Symbolic Behavior Scales Developmental Profile Caregiver Questionnaire (CSBS DP; Wetherby & Prizant, 2002), the Bayley Scales of Infant and Toddler Development – Third Edition Social-Emotional and Adaptive Behavior Questionnaire (Bayley-III; Bayley, 2005), the Inventory of Potential Communication Acts (IPCA; Sigafoos, Woodyatt, Keen, Tait, Tucker, & Roberts-Pennell, 2000), and the Communication Matrix (Rowland & Fried-Oken, 2010). These assessments use interviews or checklists to obtain insight into the child's language functioning from the perspective of the parents. Parents have more communicative interactions with their children, and more overall knowledge of them, than anyone else. For this reason, they can provide a wealth of information about each child's communication and abilities, which makes parent report measures very valuable tools. On these measures, however, parents may over-attribute intentionality to behaviors they report as a result of this familiarity (Petrovich-Bartell, Cowan, & Morse, 1982). Additionally, many of these measures fail to distinguish between observable behaviors and child intentions in the assessment items (e.g., "[child] smacks lips in a 'yum yum' gesture to indicate that something tastes good").

Information regarding early language skills can also be obtained from assessments of overall development. For example, the Mullen Scales of Early Learning (MSEL; Mullen, 1995) assesses development in five domains, including gross and fine motor skills, visual reception, and expressive and receptive language. The Vineland Adaptive Behavior Scales – Second Edition (Vineland-II; Sparrow, Balla, & Cicchetti, 2005) similarly addresses several developmental domains, including communication, daily living skills, socialization, and motor skills. The Bayley-III (Bayley, 2005) assesses adaptive behavior, cognition, language, motor skills, and social-emotional behavior. These measures provide an overview of the child's strengths and weaknesses between and within domains. Unfortunately, the relatively few test items on early language development preclude the identification of preintentional or intentional communication in the children. These assessments cannot provide SLPs with the necessary information to determine a child's level of intentionality or to plan appropriate treatment targets.

Assessment tools have also been developed that analyze a child's language skills based on language-specific behavioral samples. The behavioral samples often consist of highly structured play tasks that are designed to elicit specific language behaviors. These include the behavior sample section of the CSBS DP (Wetherby & Prizant, 2002), the decision-making trees developed by Crais and Roberts (Crais & Roberts, 1991), and the Early Social Communication Scales (ESCS; Mundy et al., 2003).

The CSBS is a norm-referenced measure that elicits behavior through a number of scripted play tasks providing information across a variety of communication domains. While some of these items provide information about intentional communication, such as gaze shifts and joint

attention, there is not enough detail about earlier communication signals to describe where a preintentional child is in this transition.

The decision-making trees also address behaviors that are elicited in a structured play context. The examiner elicits behaviors in the communicative domains of social interaction, comprehension, and verbal production, both spontaneous and imitative. Procedures are provided to assess the expressive language of children communicating at the prelinguistic, one-word utterance, and two-word and above utterance levels. However, the tool does not identify behaviors at the preintentional level.

The ESCS is a highly structured observation measure including a number of specific elicitation tasks. The behaviors produced by the child during these tasks are classified as Social Interaction Behaviors (i.e., a child's ability to engage in turn-taking interactions), Behavioral Requests, (i.e., a child's use of nonverbal behaviors to elicit aid) or Joint Attention Behaviors (i.e., a child's use of nonverbal behaviors to share object experiences with others). The ESCS assesses nonverbal communicative behaviors that typically emerge between eight and 30 months of age. The measure can also be used for children with developmental delays whose estimated communicative ability falls within this range. The ESCS is a valuable tool for using observable behaviors to determine a child's social communication ability and it is based on research in social cognition and joint attention. However, the ESCS focuses on the emergence of initiating and responding to joint attention and does not provide detailed information about preintentional communicators. Additionally, the ESCS is a highly structured assessment tool with specific scripts that may be inappropriate for individuals with severe physical impairments or severe visual limitations.

In summary, several assessments exist to measure a child's early language ability. These include parent report measures, measures of overall development, and behavioral language measures. Each measure can provide valuable information regarding language development; however, none of the measures identifies whether a child is demonstrating preintentional or intentional communication.

The Communication Complexity Scale

In response to the limitations of the existing assessments, Brady and colleagues (2012) developed the Communication Complexity Scale (CCS). Their goal was to design a criterion-referenced scale that could be used with children and adults with limited communicative ability. They designed a scale intended to measure a child or an adult's overall expressive communication level based on observable behaviors that transition through a hierarchy of communicative levels. The levels span the transition from preintentional to intentional communication and, according to the authors, reflect increasingly sophisticated interactions with a partner.

The scale, shown in Appendix A, ranges in scores from 0-11. A score of 0, for example, corresponds to "no response," and a score of 1 corresponds to "alerting – a change in behavior [in response to a stimulus]." Successive scores correspond to increasingly complex behaviors, culminating at a score of 11, "two or more word verbalizations, signs, or AAC symbol selections." The developers of the CCS marked a score of seven (i.e., triadic gaze) as the first intentional behavior in the hierarchy. Scores between 1 (i.e., alerting) and 6 (i.e., dual orientation between a person and an object or event) indicate that a child is communicating preintentionally, while scores of seven and above indicate that a child is communicating at the intentional level. A coding manual further defining each behavior is available from the authors.

Development of the CCS

Administration and Scoring. The CCS is not dependent on strict administration procedures, but rather was developed to be used in a variety of observational assessment contexts. To date, the CCS has been applied with three populations in structured play situations designed to elicit specific communicative behaviors, such as requests and comments. Three groups of researchers (Kansas-1, Kansas-2, and Washington) at two different sites (University of Kansas and University of Washington) collaborated to create the CCS. Each group administered it to a specific population. Kansas-1 targeted preschool-aged children (n = 93) with intellectual and developmental disabilities; Kansas-2 targeted individuals between 7 and 60 years of age with severe and multiple disabilities and suspected vision impairments (n = 43); Washington targeted infants 10-36 months of age with moderate-to-severe motor impairments (n = 28). Each team of researchers used a different, highly structured assessment context with their target population. In all procedures, a stimulus (e.g., toy, unusual sound) was presented and the examiner waited for a response from the participant. The most complex behavior elicited from the participant was given the corresponding CCS score. Each stimulus presentation was considered a communicative opportunity, and numerous opportunities were elicited during the course of the assessment. At the end of administration, a summary score, the average of the top three scores across all opportunities, was calculated for each individual. According to the authors, this average score controlled for variability of individual interest in stimulus items to obtain a "sensitive, overall picture of each participant's best communicative performance" (Brady, et al., p. 22).

Reliability. As part of the development of the CCS, the researchers from the three projects calculated inter-rater reliability. This was examined in three ways by comparing the scores

of two independent raters on a subset of videos from each of the three projects (57 from Kansas-1, 24 from Kansas-2, and 11 from Washington). The first analysis determined the intra-class correlation coefficients (ICCs) to determine the absolute agreement of the summary scores between two independent raters. The ICC for all three projects was .98 and for the independent projects was as follows: .95 for Kansas-1, .99 for Washington, and .95 for Kansas-2. These results indicate reliable coding across all projects. Next, the researchers examined percentage of summary score agreement. According to the authors, 62% of videos had identical CCS summary scores and 92% of videos had CCS summary scores that were at least within 1 point of each other. This calculation led to a secondary examination of the agreement between communicative categories indicated by the summary scores. The authors looked at the summary scores in terms of where they fell in the categories of preintentional (scores of $\leq$6.499), intentional nonsymbolic (scores of 6.50-9.499), and symbolic communication (scores of $\geq$9.50). They found that the "vast majority of [summary scores] by independent raters fell within the same category of communication" (Brady et al., 2012, p. 23). Finally, point-by-point reliability was calculated for individual communication opportunities in each project. According to Brady and colleagues coding was deemed consistent on items that were scored within 1 CCS point of each other. The Kansas-1 project reached 76% agreement ($\varkappa$ = .44) between two raters, the Washington project reached 89% agreement ($\varkappa$ = .77), and the Kansas-2 project reached 94% agreement ($\varkappa$ = .78). Overall, the results of these measures indicated that the researchers achieved consistent, reliable coding.

Validity. CCS scores were also compared to existing assessment tools to examine concurrent validity. Summary scores from Kansas-1 (n = 90) and Washington (n = 16) were compared

to the Expressive Language scale of the MSEL; the Pearson correlation was found to be .40 at a significance level of p = .01. Scores from Kansas-1 were also compared to the Expressive Language Scale of the Preschool Language Scale, Fourth Edition (PLS-4; Zimmerman, Steiner, and Evatt Pond, 2003). This comparison yielded a Pearson correlation of .438 at a significance level of p=.01. These validity calculations indicate that the CCS has moderate concurrent validity with existing measures.

Summary scores from the Kansas-1 project (n = 12) and the Kansas-2 project (n = 3) were also compared to the Communication Matrix, filled out online by caregivers. Analysis of these two measures indicated that the scores were similar, but were not identical. On most items, the scores on the Matrix were higher than the CCS scores, which is not unexpected due to the nature of parent report, which may over attribute intentionality. Additionally, CCS scores from the Washington project (n = 13) were compared to the CSBS DP Caregiver Questionnaire. Correlations were low overall, which the authors tentatively attributed to the high number of motor skills questions on the CSBS and the limited physical ability of the Washington participants.

Overall, the CCS has the potential to be a valuable tool for research and clinical work. It fills a need in the current body of assessments for individuals with limited communication ability and has been documented to be useful in the assessment of individuals with severe impairments. Nonetheless, more research is necessary to collect evidence of the reliability and validity of this tool. Specifically, the construct validity of the assessment should be examined to determine whether it yields accurate information regarding the transition between preintentional and intentional communication. One way to measure construct validity of the CCS is to use it to assess typically developing children who go through the transition in a predictable pattern at a predictable age.

Comparing what is known from research literature about the development of intentional communication in typically developing infants to CCS results for typically developing infants can provide evidence for the extent to which the CCS accurately measures the transition from preintentional to intentional communication. According to the research conducted by Tomasello (1995), Carpenter et al. (1998), and others, we can expect to see infants transition from preintentional to intentional communication around nine months of age. Using the CCS to examine typically developing infants at a younger age (e.g., 7 months) and again at an older age (e.g., 11 months) should determine whether the CCS can distinguish between preintentional and intentional communicators, an important measure of construct validity. There is also some evidence that intentional communication may emerge earlier than 9 months in some infants (Bakeman & Adamson, 1984). Using the CCS to assess typically developing infants at 7 and 11 months can also provide information about whether observable intentional communication behaviors, such as TG, are demonstrated in children younger than nine months of age.

Research Focus

The current study was designed to address the following questions:

Primary Research Question. When measured in groups of typically developing children at both 7 and 11 months of age, does the CCS detect a change in expressive communication behavior from preintentional to intentional communication?

Hypotheses: Based on Tomasello's "9-month revolution," the researcher hypothesizes that:

1. In the group of 7-month olds, significantly more children will have a summary score that indicates communication at the pre-intentional level.

2. In the group of 11-month olds, significantly more children will have a summary score that indicates communication at the intentional level.

Secondary Research Question. When measured using the CCS, to what extent do typically developing infants at 7 months of age demonstrate observable behaviors indicative of intentional communication?

Hypothesis: Based on research by Beuker et al. (2013) and Bakeman & Adamson (1984), the researcher hypothesizes a minority of 7-month olds in this study will demonstrate observable behaviors indicative of intentional communication.

Methods

Participants

The participants in this study were a sample of convenience drawn from a broader longitudinal study on the language development of children from 7 to 30 months of age. The participants in the longitudinal study were recruited through the University of Washington Infant Communication Studies Subject Pool, an IRB-approved pool that collects contact information from families who are willing to volunteer for research studies. The original longitudinal study included 39 infants (24 males, 15 females) from middle-to-upper class families in the Seattle area. To be included in the original study, a child was required to meet the following criteria: born within two weeks of full-term, birth weight of at least six pounds, normal hearing and vision, no significant illnesses or injuries requiring hospitalization, no cognitive or developmental concerns, no family history of speech or language difficulties, and English language exposure in

the home. The current study additionally required that the subject had video available of both the 7- and 11-month sessions from the original longitudinal study.

Data Set

A portion of each video obtained during the original longitudinal study was used for this research. This portion featured a structured play activity, with the examiner and child positioned across from each other at a table. The infant was usually seated in a high chair, but was moved to the caregiver's lap, if necessary (e.g., to calm a fussy child). The examiner presented a toy and engaged the child in play with it before presenting an obstacle (e.g., turning off the toy, putting it in a sealed container) and asking the child, "Do you want more?" The examiner then placed the toy, obstacle intact, within reach of the child and paused for up to 15 seconds. This was intended to elicit communicative, or potentially communicative, behaviors from the participant. Once the examiner felt that the child's highest level of communication had been demonstrated, or when 15 seconds had passed, the examiner removed the obstacle and re-engaged the child by playing together with the toy.

Four toys were used for this activity, with the examiner presenting four or five opportunities for each toy. When the subjects were 7 months old, the toys were a light-up musical elephant, a Berenstain Bears figurine in a closed container, bubbles, and a music box. In the 11-month videos, a wind-up stuffed bug replaced the music box and the other three toys remained the same.

While examining some videos from this potential data set, the current researcher noticed that some sessions yielded video that would be unusable for this study. For this reason, the researcher skimmed (i.e., watched on fast-forward) all 72 available videos to assess whether each

one was appropriate for the study. Specifically, the following additional criteria were used to exclude videos: participant crying or fussing throughout the entire activity, caregiver or examiner talking during most opportunities, fewer than four opportunities during which the participant was not protesting, and incomplete video that did not include structured play with the examiner. Additionally, if one video for a given participant did not meet criteria, the other video was also ruled out. Eight videos were excluded based on these criteria. After an additional four videos were set aside for training purposes, a total of 60 videos, from 30 participants, were available for the current study. These 60 videos yielded 881 total opportunities, 418 from the videos of the 7-month-old infants and 463 from the videos of 11-month-old infants. On average, each video contained 14.82 opportunities (SD = 3.08), with a range of between 8 and 22 opportunities per video.

Training

Prior to the start of research coding, four videos were coded for training purposes. The primary researcher and a University of Washington Speech and Hearing Sciences (UW SPHSC) faculty member each studied the CCS coding guidelines in depth and then independently coded each of the four training videos. Because the procedures used to present opportunities in these videos varied from those used during the development of the CCS (Brady et al., 2012), it was necessary to make some adaptions to the original coding guidelines. Specifically, "physical orientation" and "potentially communicative behaviors" (PCBs) had to be further codified because the toys were not held outside the child's reach during all opportunities as they were in Brady, et al. (2012). For a behavior to be coded as demonstrating physical orientation, the child must either have independently reached for or grabbed the toy or maintained physical contact with the toy for $\geq$ 3 seconds. In addition, the researcher added some potentially communicative behaviors

(PCBs) that included physical contact with the toy, namely: banging toys on the table, shaking the toy, and handing the toy to the examiner.

Additionally, per communication with Dr. Brady, the CCS scale had been revised since the 2012 publication. According to this new numbering, a score of 1 (i.e., alerting) - 5 (i.e., dual orientation) indicated preintentional communication, while a score of 6 (i.e. triadic orientation) or higher indicated intentional communication (N. Brady, personal communication, March 10, 2014). Please see Appendix B for the updated version of the CCS scale.

Coding of the training videos was then compared for reliability, using procedures outlined in Brady et al. (2012). Specifically, all discrepancies were discussed. Any that were due to coding errors were resolved by reference to the coding guidelines; disagreements in coding were left unchanged. A summary score was calculated for each video and these scores were compared between coders. As interpreted from Brady et al. (2012), criterion was considered to be met if both summary scores were within one CCS score (e.g., an 8.33 would be a CCS score of 8 and a 9.67 would be a CCS score of 9; therefore an 8.33 and 9.67 are within one CCS score). After comparing coding, the summary scores for all four training videos were found to surpass this criterion, meeting Brady's definition of "identical" (e.g., a 9.33 and a 9.67 both indicated a CCS score of 9) as interpreted by the researcher. Point-by-point reliability was also calculated by examining the percent of consistently scored opportunities. Brady considered scores to be consistent if they were within one CCS score (e.g., a CCS score of 4 and a CCS score of 5 for the same opportunity would be considered consistent) between the two coders. Consistency was then converted to a percent of all possible opportunities. The scores of these two judges were found to

be 85% consistent across all opportunities, again meeting the criterion of at least 76% set by Brady et al. (2012).

Preparing Video Samples for Coding

Once training was completed, a volunteer was recruited to re-number and randomize all video samples to be coded for this study. This ensured that the researcher was masked to the participant number and the age of the participant while coding. The volunteer used an online string generator to assign a random alphanumeric designation (i.e., string) to each video and then re-named the original files with the appropriate corresponding string. The same volunteer identified 12 videos (20%), balanced for age and gender, to be used for reliability coding. The reliability coder was the UW SPHSC faculty member involved in training reliability.

Coding Procedures

After the primary and reliability coders completed training and met the requirements for reliability described above, the primary researcher coded all 60 videos using the coding sheet shown in Appendix C. The process for each video involved the following steps:

1. View entire video segment once to become familiar with the child and the examiner.
2. Fill in the start time of the 1st opportunity; watch to the end of the opportunity to fill in the end time.
3. Fill in the toy used during the opportunity.
4. Watch a 3rd time to identify the highest code-able behavior; fill in the appropriate number in the "CCS code" column.
5. Write in the appropriate (sequential) opportunity number in column 1.
6. Proceed to the next opportunity and repeat steps 2-5.

Data Reduction and Analysis

The summary score, or average of the top three highest scores, was calculated for each individual participant. In order to obtain additional information about the data, descriptive statistics (e.g., mean, standard deviation, range) were also calculated for each individual participant. The corresponding CCS categories for each individual's summary score and mean were then obtained from the CCS scale as shown in Appendix B.

Outcome measures were then calculated for the 7- and 11-month groups. The mean summary score was obtained for each group, as well as the corresponding CCS category. Additionally, the mean score across all opportunities was calculated for the 7- and 11-month groups by averaging all opportunities for all participants. The CCS category based on the mean score across all opportunities was also recorded.

Due to the limited sample sizes and distributional characteristics of the data, a nonparametric Wilcoxon signed-rank test was run to answer the primary research question: When measured in groups of typically developing children at both 7 and 11 months of age, does the CCS detect a change in expressive communication behavior from preintentional to intentional communication? Additionally, outcome measures were calculated for the secondary research question: When measured using the CCS, to what extent do typically developing infants at 7 months of age demonstrate observable behaviors indicative of intentional communication? For each participant in the 7-month group, the researcher determined the raw number of scores indicating intentional communication (e.g., scores ≥ 6) and then derived the percentage of opportunities indicating intentional communication out of all opportunities. The group percentage of intentional communication scores across all opportunities was then calculated, in addition to the average

number of intentional communication scores across all participants. The range in number of intentional communication scores was also calculated to demonstrate individual variability.

Inter-rater Reliability.

The reliability coder coded 12 randomly-selected videos (20% of the total number) to examine inter-rater reliability, using procedures as interpreted from Brady et al. (2012). Specifically, reliability was calculated for summary scores and summary score categories, as well as point-by-point reliability. This researcher also calculated and compared the mean scores for each coder across all opportunities for each reliability video. Discrepancies in coding were not compared or resolved which could result in lower reliability than that set forth in Brady et al. (2012)

When coding the reliability videos, there were 12 opportunities that were identified by one coder and not the other. For the purposes of calculating reliability, these 12 opportunities were eliminated. Only the 170 opportunities that were identified and scored by both coders were used for the following calculations.

Summary score reliability, as interpreted from Brady et al. (2012), was calculated for identical summary scores (e.g., a 9.33 and a 9.67 both indicated a CCS score of 9) and scores within one CCS score (e.g., an 8.33 would be a CCS score of 8 and a 9.67 would be a CCS score of 9; therefore an 8.33 and 9.67 are within 1 CCS score). The two coders obtained identical CCS summary scores for 58% (7/12) of the reliability videos and were within one CCS score for 92% (11/12) of the videos. The CCS category based on the summary score (e.g., preintentional, intentional, etc) was identical for 100% of videos, meaning that discrepancies in summary scores between the two coders did not result in discrepancies in CCS category.

The point-by-point reliability, calculated within one CCS score, was 69% agreement between the two raters. This was calculated by comparing the CCS scores given for each opportunity based on the start and stop times of the opportunities. The total number of matching CCS scores across the 12 reliability videos (118) was then divided by the total number of opportunities (170) in these videos.

In addition to the reliability calculated by Brady et al. (2012), the researcher examined the reliability of the mean across all opportunities. The two coders obtained mean scores that reflected identical CCS scores for 50% (6/12) of the videos and were within one CCS score for 100% (12/12) of the videos. In addition, the CCS category reflected by the mean across all opportunities was identical for 75% ($\varkappa$ = .74; 9/12) of videos.

In summary, inter-rater reliability for this study was comparable to the reliability found in Brady et al. (2012). Specifically, the same percentage (92%) of summary scores was within one CCS score in both studies, although fewer summary scores were actually identical in the current study (58% compared to 62%). Point-by-point reliability was slightly worse in this study than in Brady et al. (2012), 69% compared to 76%, but that was to be expected without correcting discrepancies. Overall, the reliability for this use of the CCS was comparable to the reliability of coding for the original CCS study.

Results

The primary research question was as follows: When measured in groups of typically developing children at both 7 and 11 months of age, does the CCS detect a change in expressive communication behavior from preintentional to intentional communication? As a first step in addressing the primary research question, the researcher calculated the summary score, along

with the corresponding CCS category for each individual participant. Table 2 below reports the percentage of participants in each CCS category (e.g., preintentional, intentional nonsymbolic, intentional symbolic) based on their individual summary scores.

Table 2:

CCS Categories by Age Group Based on Summary Score		
	7 months	**11 months**
Preintentional Category	0% (0/30)	0% (0/30)
Intentional Nonsymbolic Category	100% (30/30)	97% (29/30)
Intentional Symbolic Category	0% (0/30)	3% (1/30)

The mean CCS score across all opportunities was calculated for each individual participant and the corresponding CCS category was identified. Table 3 below reports the percentage of participants in each CCS category (e.g., preintentional, intentional nonsymbolic, intentional symbolic) based on their individual mean score across all opportunities.

Table 3:

CCS Categories by Age Group Based on Mean Across All Opportunities		
	7 months	**11 months**
Preintentional Category	47% (14/30)	47% (14/30)
Intentional Nonsymbolic Category	53% (16/30)	53% (16/30)
Intentional Symbolic Category	0% (0/30)	0% (0/30)

Group outcome measures were calculated for the 7- and 11-month groups. The mean summary score and corresponding CCS category were obtained for each group, as well as the mean score across all opportunities and the corresponding CCS category. Table 4 below reports the results of these outcome measures for the 7- and 11-month groups.

Table 4:

Outcome Measures for 7- and 11-Month Groups		
	7 months	**11 months**
Mean Summary Score	8.93 (SD = 1.05)	9.18 (SD = .874)
CCS Category based on Mean Summary Score	Intentional Nonsymbolic	Intentional Nonsymbolic
Mean Across All Opportunities	6.07 (SD = .933)	6.21 (SD = .95)
CCS Category based on Mean Across All Opportunities	Intentional Nonsymbolic	Intentional Nonsymbolic

The mean summary scores were compared for the 7- and 11-month groups. A nonparametric Wilcoxon signed-rank test revealed non-significant differences in mean summary score between infants at 7 months of age (mean rank = 13.56) and the same infants when assessed four months later at 11 months of age (mean rank = 11.87), $Z=-.80$, $p=.42$, $r=.15$. Additionally, the mean across all opportunities was compared for the two groups. The nonparametric Wilcoxon signed-rank test revealed non-significant differences in mean across all opportunities between the infants at 7 months (mean rank = 15.05) and the same infants when assessed four months later at 11 months (mean rank = 16.27), $Z=-1.10$, $p=.27$, $r=.20$. These results demonstrate no statistical difference between the performance of the infants at 7 and 1 months, as measured by both the mean summary score and the mean across all opportunities.

Outcome measures were then calculated for the secondary research question: When measured using the CCS, to what extent do typically developing infants at 7 months of age demonstrate observable behaviors indicative of intentional communication? The scores for all 7-month-old participants were examined for instances of intentional communication behaviors. All 30 infants (100%) demonstrated intentional communication, as indicated by a CCS score of ≥ 6. The range varied from as few as four to as many as 15 intentional communication behaviors per video. When measured across all 7-month-old participants, 55% of opportunities (231/418) received a score at or above the intentional level (e.g., ≥ 6). For individual participants, the percentage ranged from between 20% and 86% of opportunities. The average number of intentional communication scores per video was 7.7 (SD = 3.00).

Discussion

This study used the CCS to assess the same typically developing infants at 7 and 1 months of age to determine whether it could detect the transition in this population from preintentional to intentional communication. Using the CCS in this way would produce evidence for the measure's ability to distinguish between preintentional and intentional communicators and would therefore contribute to what is known about the construct validity of the tool. The findings from this study were unexpected in two important respects. First, the primary researcher had hypothesized that there would be a significant difference in communicative behaviors between two groups as measured by the CCS. This hypothesis was based on the current child language literature that suggests that children demonstrate a change from preintentional to intentional communication between these two ages, a change that the CCS was designed to measure (Tomasello,

1995; Carpenter et al., 1998; Mundy et al., 2007; Beuker et al., 2013). However, the results of this study showed no significant difference between these two groups, whether calculated using a measure of best performance, the mean summary score, or a measure of overall performance, the mean across all opportunities. For both groups, the summary scores indicated a higher level of communicative function than the mean across all opportunities. However, both the mean summary score and the mean across all opportunities indicated that the two groups were communicating at the intentional nonsymbolic level. The results of this study, therefore, do not demonstrate construct validity for the CCS.

A closer look at that finding brings us to the second unexpected result in this study. Both group and individual data indicate that 7-month-old infants were already communicating at the intentional level. The mean summary score for the group of 7-month-old children was 8.93, well into the intentional communication category. Perhaps more interesting is the fact that the summary scores for all individual 7-month-old infants also indicated intentional communication. This means that every 7-month-old in the study was observed using TG or another behavior indicating intentional communication in at least three opportunities. In other words, intentional communication could be considered to be at least emerging in all 30 participants at 7 months of age.

Based on the body of child development research, it was unexpected that all 7-month-old participants would demonstrate intentional communication behaviors. A majority of research studies indicate that intentional communication emerges during the "9-month revolution" (Tomasello, 1995; Tomasello, 1999; Mundy et al., 2007; Carpenter et al., 1998). Two research studies have suggested that intentional communication may appear in children below nine months of

age. Beuker et al. (2013) found that some children as young as eight months demonstrated emerging intentional communication during structured elicitation tasks and Bakeman & Adamson (1984) documented emerging intentional communication in some six-month-old infants during free play. The researcher, therefore, expected to find emerging intentional communication in a minority of 7-month olds but did not expect that intentional communication behaviors would be apparent in all 30 infants at this young age.

Such unexpected results require some additional inquiries. Did these children truly demonstrate these behaviors at this age or are the results an artifact of the CCS testing procedures, coding, or analysis? The CCS was designed to examine observable behaviors and for this reason, all coding and the resultant scores were based on discrete, observable behaviors such as triadic gaze (TG). It seems unlikely, therefore, that coders would identify such specific intentional communication behaviors if they were not present.

On the other hand, the results of this study may have been influenced by limitations related to administration procedures. Due to the use of a convenience sample, the procedures could not be changed or manipulated by the researcher. The procedures used in the videos differed from those used in Brady, et al (2012). Most notably, the presented toys were frequently placed within the child's reach, which allowed them to respond by physically manipulating the toy, rather than through purely non-tactile means as in Brady, et al (2012). Additionally, the presentation of opportunities was inconsistent, with examiners using different verbal prompts and waiting varied lengths of time after presenting the toys. Examiners also demonstrated inconsistent behaviors during opportunities, with some trying to engage the infants and others remaining neutral. The participants demonstrated different interest levels in the various toys presented during the

study. The degree to which a child enjoyed the toy may have impacted their response when the obstacle was presented. The inconsistency of administration procedures may have influenced the results by inflating the scores for some participants (e.g., participants with a more engaging or responsive examiner) and deflating the scores for others (e.g., participants with a less engaging or responsive examiner).

Lastly, the results of this study may also have been impacted by the population of the participants. The convenience sample included only infants from middle-upper class families who volunteered to be included in the Infant Communication Studies Subject Pool. Certain factors, such as SES and family interest in communication, may have led to early communication development among the participants. This could have contributed to the emergence of intentional communication in the 7-month-old children. The extent to which limitations (e.g. administration procedures, population) impacted the results of this study is currently unclear.

Future Directions

The construct validity of the CCS should continue to be examined to determine whether the tool yields accurate information regarding the transition between preintentional and intentional communication. Specifically, a longitudinal study should be conducted in which the CCS is used to examine typically developing infants at set intervals during the first year of life. In order to avoid the limitations of the current study, the procedures should be fixed and consistently followed across participants and across ages. The study would ideally include a heterogeneous participant pool with infants from a variety of socioeconomic, racial, and educational backgrounds. A study of this nature would allow researchers to examine the construct validity of the CCS without influence from the confounding and limiting factors present in the current study.

If the CCS is proven to be reliable and valid, research should be done regarding the different methods of scoring. The two scoring methods used in this study (i.e., the summary score and the mean across all opportunities) could both be potentially useful when assessing and planning intervention for children with disabilities. Since the summary score is based on only the top three scores, it is a measure of the best performance across all opportunities. It summarizes the most advanced communication that a child demonstrates and may reflect communication behaviors that are newly emerging. The mean across all opportunities is a measure of overall performance. It summarizes the child's communication during all opportunities and across all toys. The mean across all opportunities may be more reflective of a child's typical performance and typical communicative repertoire. Overall, the two scores taken together provide a more complete description of a child's performance. A comparison of the two scores might be useful to clinicians, in conjunction with other assessments, when determining treatment targets. For example, a difference in performance may indicate the need to support the development and stabilization of emerging behaviors. Agreement between the two scores could indicate that the child was not enticed to demonstrate their best communication or is not currently using any emerging communication skills. Nonetheless, before the CCS can be used for planning treatment, more evidence must be produced regarding the reliability and validity of the measure.

References

Bakeman, R., & Adamson, L. B. (1984). Coordinating attention to people and objects in mother-infant and peer-infant interaction. Child Development, 55, 1278-1289.

Bates, E., Benigni, L., Bretherton, I., Camaioni, L., & Volterra, V. (1979). The emergence of symbols: Cognition and communication in infancy. New York, NY: Academic Press.

Bayley, N. (2005). Bayley Scales of Infant and Toddler Development-Third Edition. San Antionia, Tx. Harcourt Assessment.

Beuker, K. T., Rommelse, N. N. J., Donders, R., & Buitelaar, J. K. (2013). Development of early communication skills in the first two years of life. Infant Behavior and Development, 36, 71-83.

Brady, N. C., Fleming, K., Thiemann-Bourque, K., Olswang, L., Dowden, P., Saunders, M. D., & Marquis, J. (2012). Development of the communication complexity scale. American Journal of Speech-Language Pathology, 21, 16-28.

Carpenter, M., Nagell, K., & Tomasello, M. (1998). Social cognition, joint attention, and communicative competence from 9 to 15 months of age [Monograph]. Monographs of the Society for Research in Child Development, 63(1).

Crais, E. R., & Roberts, J. E. (1991). Decision making in assessment and early intervention planning. Language, Speech, and Hearing Services in the Schools, 22, 19-30.

Davis, B.E. (2013, October). Developmental Red Flags. LEND Core Seminar. Lecture conducted from University of Washington, Seattle, Wa.

Fenson, L., Dale, P., Reznick, J. S., Bates, E., Thal, D. J., & Pethick, S.J. (1994). Variability in early communicative development [Monograph]. Monographs of the Society for Research in Child Development, 59(5).

Greenslade, K., Olswang, L. B., Weaver, A., Dowden, P., Feuerstein, J., & Pinder, G. L. (2014). The effect of child-directed intervention on communicative interactions between care-gi vers and their young children with severe disabilities. Manuscript in preparation.

Halle, J., Brady, N., C., & Drasgow, E. (2004). Enhancing Socially Adaptive Communicative Repairs of Beginning Communicators with Disabilities. American Journal of Speech-Language Pathology, 13, 43-54.

Iacono, T., Carter, M., & Hook, J. (1998). Identification of intentional communication in students with severe and multiple disabilities. AAC: Augmentative and Alternative

Communication, 14(2), 102-114.

Mullen, E. (1995). Mullen Scales of Early Learning: AGS Edition. Circle Pines, MN: AGS.

Mundy, P., Block, J., Delgado, C., Pomares, Y., Van Hecke, A. V., & Parlade, M. (2007). Individual differences and the development of joint attention in infancy. Child Development, 78(3), 938-954.

Mundy, P., & Newell, L. (2007). Attention, joint attention, and social cognition. Current Direc tions in Psychological Science, 16(5), 269–274.

Mundy, P., Card, J., & Fox, N. (2000). EEG correlates of the development of infant joint attention skills. Developmental Psychobiology, 36, 325-338.

Mundy, P., Sigman, M., & Kasari, C. (1990). A longitudinal study of joint attention and language development in autistic children. Journal of Autism and Developmental Disorders, 20(1), 115–28.

Olswang, L. B., Feuerstein, J. L., Pinder, G. L., & Dowden, P. (2013). Validating dynamic assessment of triadic gaze for young children with severe disabilities. American Journal of Speech-Language Pathology (22), 449-462.

Paparella, T., Goods, K. S., Freeman, S., & Kasari, C. (2011). The emergence of nonverbal joint attention and requesting skills in young children with autism. Journal of Communication Disorders, 44, 569-583.

Paparella, T., & Kasari, C. (2004). Joint attention skills and language development in special needs populations: translating research to practice. Infants and Young Children, 17(3), 269-280.

Petrovich-Bartell, N., Cowan, N., & Morse, P. (1982). Mothers' perceptions of infant distress vocalizations. Journal of Speech and Hearing Research, 25, 371-376.

Proctor, A., & Murnyack, T. (1995). Assessing communication, cognition, and vocalization in the prelinguistic period. Infants and Young Children 7(4), 39-54.

Rowland, C., & Fried-Oken, M. (2010). Communication matrix: A clinical and research assessment tool targeting children with severe communication disorders. Journal of Pediatric Rehabilitation Medicine: An Interdisciplinary Approach, 3, 319-329.

Sigafoos, J., & Mirenda, P. (2002). Strengthening communication behaviors for gaining access to desired items and activities. In J. Reichle, D. Beukelman, & J. Light (Eds.), Exemplary

practices for beginning communicators: Implications for AAC (pp. 123-156). Baltimore: Paul H. Brookes Publishing Co.

Sigafoos, J., Woodyatt, G., Keen, D., Tait, K., Tucker, M., Roberts-Pennell, D., & Pittendreigh, N. (2000). Identifying potential communicative acts in children with developmental and physical disabilities. Communication Disorders Quarterly, 21(2), 77-86.

Sparrow, S. S., Balla, D. A., & Cicchetti, D. V. (2005). Vineland Adaptive Behavior Scales: Second Edition. Circle Pines, MN: American Guidance Service, Inc.

Tomasello, M. (1995). Joint attention as social cognition. In C. Moore & P. J. Dunham (Eds.) Joint attention: Its origins and role in development (pp. 103-130). Hillsdale, NJ: Erlbaum.

Tomasello, M. (1999). Having intentions, understanding intentions, and understanding communicative intentions. In P. Zelazo, J. Astington, & D. Olson (Eds.), Developing theories of intention: social understanding and self-control (pp. 63-75). Mahwah, NJ: Lawrence Erlbaum Associates.

Trevarthen, C., & Hubley, P. (1978). Secondary intersubjectivity: confidence, confiding, and acts of meaning in the first year. In A. Lock (Ed.), Action, gesture and symbol: The emergence of language (pp. 183–229). London: Academic Press.

Wetherby, A., & Prizant, B. (2002). Communication and Symbolic Behavior Scales Development Profile. Baltimore, MD: Brookes.

Zimmerman, I., Steiner, V., & Evatt Pond, R. (2003). Preschool Language Scale, Fourth Edi tion. San Antonio, Tx: The Psychological Corporation.

Appendices

Appendix A: Communication Complexity Scale (Brady et al., 2012)

Number	Definition	Example	Communication Level
0	No response	An opportunity is presented, but the child looks away the entire time	
1	Alerting – a change in behavior	A vibrating toy stops vibrating, and the child stops smiling	Preintentional
2	Single object/event/ person orientation	Child handles a toy and focuses attention only on this toy	Preintentional
3	Single object/event/ person orientation plus 1 PCB	Child handles a toy and vocalizes	Preintentional
4	Single object/event/ person orientation plus more than 1 PCB	Child reaches toward a toy and vocalizes	Preintentional
5	Scanning between objects/events	The child visually scans (shifts attention) between two different windup toys	Preintentional
6	Dual orientation between a person and an object or event	While playing with a windup toy, the child looks up at partner	Preintentional
7a	Triadic gaze	Child looks from toy to partner and back to toy within a few seconds	Intentional nonsymbolic
7b	Dual orientation plus 1 or more PCBs	Child looks from toy to partner and vocalizes	Intentional nonsymbolic
8	Triadic gaze plus 1 PCB	Child looks from toy to partner and back to toy while vocalizing	Intentional nonsymbolic
9	Triadic gaze plus more than 1 PCB	Child looks from toy to partner and back to toy while vocalizing and giving toy to partner	Intentional nonsymbolic
10	One word verbalization, sign, or AAC symbol selection	Child says “more” to request more Cheerios	Intentional symbolic
11	Two or more word verbalizations, signs, or AAC symbol selections	Child says “more please” to request more Cheerios	Intentional symbolic

Appendix B: Modified Communication Complexity Scale

Number	Definition	Example	Communication Level
0	No response	An opportunity is presented, but the child looks away the entire time	
1	Alerting – a change in behavior	A vibrating toy stops vibrating and the child stops smiling	Preintentional
2	Single object/event/ person orientation	Child handles a toy and focuses attention only on this toy	Preintentional
3	Single object/event/ person orientation plus 1 PCB	Child handles a toy and vocalizes	Preintentional
4	Single object/event/ person orientation plus more than 1 PCB	Child reaches toward a toy and vocalizes	Preintentional
5	Dual orientation between a person and an object or event	While playing with a windup toy, the child looks up at partner	Preintentional
6	Triadic orientation	Child looks from toy to partner and back to toy within a few seconds	Intentional nonsymbolic
7	Dual orientation plus 1 PCBs	Child looks from toy to partner and vocalizes	Intentional nonsymbolic
8	Dual orientation plus 1 or more PCBs	Child looks from toy to partner, points and vocalizes	Intentional nonsymbolic
9	Triadic gaze plus 1 PCB	Child looks from toy to partner and back to toy while vocalizing	Intentional nonsymbolic
10	Triadic gaze plus more than 1 PCB	Child looks from toy to partner and back to toy while vocalizing and giving toy to partner	Intentional nonsymbolic
11	One word verbalization, sign, or AAC symbol selection	Child says “more” to request more Cheerios	Intentional symbolic
12	Two or more word verbalizations, signs, or AAC symbol selections	Child says “more please” to request more Cheerios	Intentional symbolic

Appendix C: CCS Coding Form

Opportunity #	Opportunity Start Time	Opportunity Stop Time	Toy Presented	CCS Code	Rationale/Notes