UNDERSTANDING THE DYAD: ADAPTATION OF A VIDEO-BASED CODING SYSTEM FOR INTERACTIONS BETWEEN ADULTS AND YOUNG CHILDREN

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ABSTRACT

Background: Supportive relationships with caring adults are among the most important environmental influences on children's brain development. Children growing up in adverse circumstances are at higher risk for a vast number of negative behavioral and health outcomes. Evidence suggests that improving the quality of interactions between adults and young children can buffer the impact of adversity. Researchers who study adult-child interactions need a reliable tool to assess a wide range of behaviors known to improve child development.

Objectives: (1) Adapt the Simple Interactions video feedback tool to allow for in-depth coding of behavioral interactions between parents and their children aged 3 to 6. (2) Test the reliability of this new coding system.

Methods: 23 videos of parent-child interactions were collected as part of an ongoing research study. A series of flowchart-style diagrams were developed to guide the decision-making process of coding these dyadic interactions.

Results: Three flowchart diagrams, each corresponding to a feature of adult-child relationships shown to support brain development, were developed through a collaboration with the Simple Interactions research team. Analyses of inter-rater reliability demonstrated a high degree of consistency between coders.

Conclusions and Public Health Significance: This measurement system could be used in any research setting geared toward studying children's social-emotional development. It can be used to improve outcomes for children living in adverse environments through providing in-depth assessment of adult-child interactions.

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PREFACE

I would like to thank my thesis committee: Dr. Christina Mair, Dr. Jeanette Trauth, and Dr. Judy Cameron. If this thesis is any good, it's because of their incredible feedback, patience, and encouragement during the writing process. I underestimated how much I really needed it all. Additional thanks go to Alex, Marissa, Jules, and Swetha. This has been a team effort which wouldn't have been possible without their collaboration, hard work, and willingness to tell me when I'm wrong. Thank you to Simple Interactions, the Allegheny County Family Support Centers, all the participants in the study, and Working For Kids.

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1.0 INTRODUCTION

Environmental influences play a significant role in children's brain development (Shonkoff & Phillips, 2000; Shonkoff, Boyce, & McEwen, 2009; Stiles & Jernigan, 2010; Cassidy & Shaver, 2016). Among these influences, supportive relationships with caring adults are among the most important (Thompson, 2000; Shonkoff & Phillips, 2000; Siegel, 2001). Research demonstrates that healthy relationships are characterized by certain basic qualities that allow children to learn skills which will be important throughout their lifespan. These qualities can be summarized as *emotional connection, reciprocal contribution to interactions*, and *appropriate progressive challenges facilitated by adults* (Bronfenbrenner, 1979; Harrist, 1994; Kochanska, 2002; Li & Julian, 2012; Cassidy & Shaver, 2016). Children growing up with relationships consisting of these qualities are more likely to develop into healthy, well-rounded adults (Thompson, 2000; Siegel, 2001). On the other hand, children growing up experiencing extreme adversity such as abuse and neglect are at increased risk for many negative measures of health, such as cancer, obesity, heart disease, and depression (Felitti et al., 1998; Dube et al., 2003; Flaherty et al., 2013; Bright, Knapp, Hinojosa, Alford & Bonner, 2015). This is especially true among children who lack supportive relationships with caring adults (Manly, Kim, Rogosch, & Cicchetti, 2001).

To rigorously study how interactions support child development as well as buffer children against the impact of stress, researchers need a measurement system which allows them to quantify adult-child interactions with close precision. Several systems have been developed to score adult-child interactions (e.g. Egeland & Hiester, 1995; Kochanska & Aksan, 1995; Mize & Pettit, 1997; Keown & Woodward, 2002), but each one is limited in some way. For example, some are designed primarily to provide qualitative feedback to adults, some are appropriate for scoring interactions with infants but not older children, and some are only intended for use during highly structured interactions. This paper describes the development of a scoring system for quantifying adult-child interactions that fills an important methodological gap, being useful with a wide age range of young children across a variety of non-structured interaction contexts with adults.

Through a community partnership with a subset of the Family Support Centers in Allegheny County, a pilot study was conducted assessing the feasibility of implementing a neuroscience-based educational intervention to teach parents of young children living in adverse circumstances how to facilitate sturdy brain development in their children. Various developmental measures were collected for a one-year period after the intervention, which included measures of cognitive development, sleep, and a biological marker of cellular stress. Additionally, to measure social-emotional development, videos were collected of parents interacting with their three- to six-year-old children. The scoring system presented here was developed out of a need to quantify these videos in order to make comparisons between children and across the one-year period of the study.

This new measurement system contributes to public health research by providing a tool to assess adult-child interactions quantitatively as well as qualitatively: it acts as a quantitative measure in that it utilizes a highly specific approach to video-coding; it acts as a qualitative measure in that it provides a detailed assessment of adult-child interaction quality. Its accessibility and comprehensiveness makes it a viable measurement system for any researchers investigating adult-child interactions. Ultimately, the tool can also be used to evaluate an intervention's ability to improve these interactions.

This thesis describes the process of developing the scoring system and assessing its reliability. The second chapter outlines the process of human brain development, how environmental influences impact development, the importance of healthy interactions for supporting brain development, and current methods of assessing videos of adult-child interactions in research. The third chapter details the process of developing the scoring system, as well as of collecting and analyzing the data necessary to accomplish this task. Chapter four contains the results of these processes, and chapter five examines their implications and importance. The sixth and final chapter summarizes and synthesizes the preceding chapters and discusses the measure's overall significance.

2.0 BACKGROUND

2.1 THE SCIENCE OF BRAIN DEVELOPMENT

In considering the process of brain development, it is best not to think of the brain as a single organ, but as a collection of multiple structures working together. At a gross level, the brain can be broken down into three major divisions – the forebrain, the midbrain, and the hindbrain – with each division consisting of smaller, more specialized areas. Each of these areas is made up of many neural circuits. Circuits are established by genetics, but they are strengthened through repeated use. Each circuit plays a distinct role and responds to unique categories of stimuli (Stern, 2001; Nelson et al., 2002; Damoiseaux et al., 2006; Tau & Peterson, 2010).

Different neural circuits develop at different times throughout the lifespan: those responsible for the most basic functions – such as the visual cortex, which performs visual processing – begin to develop prenatally and finish developing in the early years of life. The more advanced structures finish developing by approximately 25 years of age (Bourgeois & Rakic, 1993; Sowell, Thompson, Holmes, Jernigan & Toga, 1999; Tau & Peterson, 2010; Stiles & Jernigan, 2010). Interaction between neural circuits is essential to brain functioning. For example, within the visual cortex, distinct circuits – some of which respond to color, some to motion, and some to shape – act together to process visual information. To function, the visual cortex relies on other structures within the brain: the temporal cortex, which helps process memories; the motor cortex, which helps guide movement; and the prefrontal cortex, which helps make sense of what is being seen (Gilbert & Li, 2013; Dijkstra, Zeidman, Ondobaka, van Gerven & Friston, 2017).

Nearly all neurons are in place by birth, but the process of brain development entails the establishment, strengthening, and weakening of circuits. An individual's genetics are responsible for determining the timing with which connections form between neurons. Once connections are formed, a child's experiences will dictate which connections endure over time. The most-used circuits are strengthened through frequent stimulation, whereas the least-used circuits are more likely to be "pruned," or reduced (Levitt, 2003; Tau & Peterson, 2010; Stiles & Jernigan, 2010). The period when connections are forming and being pruned in a specific neural circuit is referred to as the period of plasticity (Konorski, 1948; Citri & Malenka, 2008). The combined, systematic process of strengthening and pruning occurs in all developing brain circuits, and is a key component in establishing long-lasting neural circuitry.

The human brain is not fully developed at birth. Almost all neurons are produced prenatally and are in place within the brain at birth, but the formation of connections between neurons (i.e. brain pathways) is a process that begins before birth and continues through the first several decades of life (Matsuzawa et al., 2001; Tau & Peterson, 2010; Stiles & Jernigan, 2010). However, the early years of life are extraordinarily important for ensuring strong overall development. For example, circuitry for sensory pathways begin to develop connections prenatally and are pruned through the first year of life (Rice & Barone, 2000; Tau & Peterson, 2010; Stiles & Jernigan, 2010). A landmark experiment by Hubel and Wiesel (1964) illustrated this phenomenon. Their study demonstrated that when kittens are deprived of any visual stimuli during the visual cortex's plastic period, they will never develop the ability to see – this helps emphasize the importance of the period of plasticity. Pathways associated with motor skills, emotion regulation, and communication skills are plastic in early to mid-childhood (Shonkoff & Phillips, 2000; Newport, Bavelier, & Neville, 2001). The brain area that finishes developing the latest is the prefrontal cortex

– new neural circuits are formed here until about age 12, but pruning continues until approximately age 25 (Giedd et al., 1999).

One analogy for conceptualizing the developing brain is that of *Brain Architecture* (FrameWorks Institute, 2005). Just as a well-constructed building needs a robust foundation, so does a well-developed brain. A child's environment is a primary contributing factor to the brain's structural integrity.

2.2 IMPACT OF ENVIRONMENTAL INFLUENCES

Children's brain development is strongly influenced by the environments in which they are raised (National Scientific Council on the Developing Child, 2007). In the most basic sense, brain pathways are reinforced according to what the individual does the most. Brain development is a process of adaptation to the environment. Connections are strengthened and pruned irrespective of the implications of positive or negative long-term effects – whatever experiences the brain is exposed to most frequently will be the experiences to which the brain adapts (Shonkoff & Phillips, 2000; Shonkoff et al., 2009; Stiles & Jernigan, 2010; Cassidy & Shaver, 2016). In this way, neural circuitry is constantly adjusting to optimize for what is occurring during each circuit's plastic period.

Building strong brain pathways for a skill requires practicing that skill repeatedly. For example, to build strong communication skills, children must continually practice different forms of communication. One study demonstrated that, when children are exposed to high amounts of oral communication from parents, they develop more extensive vocabularies compared to children whose parents speak to them less often (Huttenlocher, Haight, Bryk, Seltzer & Lyons, 1991). This principle applies to all skills – motor skills, math skills, social-emotional skills, and complex problem-solving (Shonkoff & Phillips, 2000; Cunha, Heckman, Lochner, & Masterov, 2005; Knudsen, Heckman, Cameron & Shonkoff, 2006). It follows that children who do not continually practice these useful skills will not form the strong neural pathways necessary to attain their optimal performance within these domains. It is important to recognize that processes not typically thought of as "skills" can also have their neural circuitry strengthened, if the brain is doing them enough. For example, if children are exposed excessively to an undesirable condition such as the stress from anger or fear, the circuitry used when stress occurs will strengthen over time (Loman & Gunnar, 2010; Thompson, 2015), which can lead to negative health outcomes later in life (Hertzman, 2000; McEwen, 2008).

A child's environment is a dynamic, intricate network of influences which plays an instrumental role in determining the degree to which he or she will learn many important skills. Overall, one of the most impactful environmental influences on children's brain development is the relationships they have with caring adults (Shonkoff & Phillips, 2000; Shonkoff et al., 2009). In fact, supportive relationships consisting of strong, nurturing interactions can be considered one of the most important factors in determining how a child will develop.

2.3 HEALTHY RELATIONSHIPS CONSIST OF STRONG INERACTIONS

Interactions with caring adults help to positively shape brain development (Thompson, 2000; Siegel, 2001). There are many ways in which an interaction can be beneficial to a child, but there are some characteristics that are universally agreed upon by researchers as being effective. There is scientific consensus that certain interaction qualities have a positive impact on children's development (Bronfenbrenner, 1979; Harrist, 1994; Kochanska, 2002; National Scientific Council on the Developing Child 2004; Li & Julian, 2012; Cassidy & Shaver, 2016). These characteristics can be summarized as *strong emotional connection, reciprocal contribution*, and *progressive challenges*.

Strong emotional connection is mutual emotional affect and high levels of engagement between the adult and child, with the adult being receptive to the child's emotional cues. *Reciprocal contribution* is interactions with balanced engagement and involvement from the parent and child, with neither dominating the interaction. This is sometimes referred to as "serve and return." *Progressive challenges* are age-appropriate, incremental challenges for the child facilitated by the adult.

Supportive relationships provide guidance and positive feedback, encouraging children to learn new skills. To learn something new, a child must first become interested in the skill and then engage the neural circuitry that allows him or her to learn it. Practicing the skill repeatedly will strengthen brain pathways for that skill and build self-confidence for doing the activity. With self-confidence, the child can progress to more difficult and challenging tasks (Vygotsky, 1978; Ericsson, Nandagopal & Roring, 2009). A series of positive interactions can serve to facilitate this process, inspiring the child to become interested in learning the skill, supporting the child when first attempting the skill, and encouraging the child to repeatedly practice the skill (Mashburn et al., 2008). Without support and encouragement, children's brains are less likely to develop the strong circuitry associated with a wide range of important skills (Nelson et al., 2002; Heckman, 2006).

2.4 SUPPORTIVE RELATIONSHIPS BUFFER STRESS

Exposure to some stress allows children to learn how to effectively manage adversity. Children must learn to deal with moderate stress in order to develop stable coping mechanisms, and living in an environment of supportive relationships can facilitate this learning process (Bronfenbrenner, 1979; Gunnar, Brodersen, Nachmias, Buss & Rigatuso, 1996; Shonkoff & Phillips, 2000). Healthy relationships – which consist of strong, nurturing interactions – act as a buffer for the stress through providing the child with guidance as to how to cope with stressors (Nachmias, Gunnar, Mangelsdorf, Parritz & Buss, 1996; Shonkoff et al., 2009). This is upheld by the literature: one study suggests that the presence of a supportive mother helps inhibit cortisol – a hormone released in response to stress – in children (Nachmias et al., 1996). On the other hand, relationships that lack support will create an environment where a child is less likely to learn to manage stress in the healthiest way (Manly et al., 2001).

In contrast to moderate stress, significant adversity in childhood can have negative long-term consequences. When children are exposed to traumatic experiences without support from caring adults, their brains adapt to the adverse environmental stimuli to try to cope without support (De Bellis & Zisk, 2014). For example, when a child grows up in an environment constantly witnessing anger, his or her neural connections for recognizing anger will strengthen. Anger is a complex emotion which can be displayed in many ways. When anger-recognizing brain pathways are strengthened, a person will be more likely to perceive anger on a daily basis throughout his or her life, even when it is not present in others (Pollak, Cicchetti, Hornung & Reed, 2000).

These adverse environments can lead to changes in the brain that negatively affect health throughout the lifespan. This occurs through a variety of mechanisms, including strengthening of brain pathways for recognizing and responding to adversity, and long-term changes in gene expression in the brain (De Bellis & Zisk, 2014; McEwen, Gray & Nasca, 2015), as well as decreasing time spent strengthening brain pathways for other skills a child will need later in life. Adverse Childhood Experiences (ACEs) – different categories of abuse, neglect, and household dysfunction – are adverse or traumatic events that occur during childhood (Felitti et al., 1998). Research demonstrates a relationship between exposure to ACEs and increased risk for a variety of physical, mental, and developmental conditions in childhood (Bright et al., 2015). These effects last into adulthood and are associated with many of the leading causes of death, including heart disease, cancer, and diabetes (Felitti et al., 1998). Moreover, the relationship is graded among every age group – exposure to more categories of ACEs is linked to increasingly worse health outcomes (Felitti et al., 1998; Dube et al., 2003; Flaherty et al., 2013).

Children of ACEs-exposed parents are more likely to experience ACEs than children of parents with no ACEs (Randell, O'Malley & Dowd, 2015). This intergenerational effect demonstrates that adverse circumstances may act as a significant barrier preventing families living in stressful environments from attaining the healthiest possible development for their children. Parents who experienced ACEs may not be as good at providing caring, responsive feedback to their children because they did not learn this during their own childhood. This renders them less likely to be able to buffer stress for their children. Furthermore, certain factors such as low socioeconomic status are associated with increased likelihood of ACE exposure (Bethell, Newacheck, Hawes & Halfon, 2014). Together, these data suggest a particularly urgent need to mitigate the risks associated with ACEs within vulnerable populations.

The importance of supportive interactions is being recognized by policymakers, practitioners, and researchers. This is reflected in programs and interventions which, among other things, emphasize educating adults on the best ways to interact with young children (Head Start

Bureau, 2001; Fox & Smith, 2007; U.S. Department of Health and Human Services, 2012; Jones & Bouffard, 2012; Williford, Vick Whittaker, Vitiello & Downer, 2013). Evidence suggests that programs focusing on building healthy adult-child relationships are effective in improving child developmental outcomes (Bakermans-Kranenburg, van IJzendoorn & Juffer, 2003; Shonkoff & Fisher, 2013). Since improving interactions can positively impact brain development, researchers need to have the means to reliably assess these interactions in a quantitative manner. Given that dyadic interactions between adults and children contain such an extensive amount of detail and information, an effective way to do this is through videotaping interactions.

2.5 CURRENT INTERVENTIONS TO IMPROVE ADULT-CHILD INTERACTIONS USING VIDEO FEEDBACK

Adult-child interactions are highly complex behavioral systems, so in-person observations are likely to overlook important details of the interaction. One effective means of providing adults with in-depth commentary on how they interact with children is through video feedback (McDonough, 1995, 2000; Brooks, 2008; Van Vonderen, Duker, & Didden, 2010). These feedback interventions entail videotaping interactions and later showing them to the participants to highlight strengths and, in some cases, point out weaknesses (Vik & Rohde, 2014; Akiva, Li, Martin, Horner & McNamara, 2016).

Video feedback interventions are often conducted with vulnerable populations, such as with families living in low socioeconomic conditions, or who are involved in child protective services (Bernard, Dozier, Bick & Gordon, 2014; Fisher, Frenkel, Noll, Berry & Yockelson, 2016). Since children in these situations are at higher risk for experiencing the long-term effects of adversity (Brooks-Gunn & Duncan, 1997), many organizations and institutions are motivated to provide additional resources to help guide these families toward an increased understanding of how healthy interactions can positively shape brain development.

With video feedback, the video recordings are themselves a part of the intervention. Because of this, quantification of the interaction is not a central feature; rather the focus is on recognizing the quality of interactions. For example, to teach parents about the importance of reciprocal interactions with children, the researcher will identify an example of the parent and child having a reciprocal exchange together, show this example to the parent, and encourage this sort of behavior in the future. This paradigm allows researchers to identify examples in the laboratory and provide feedback later. They can then assess the intervention's effectiveness with non-behavioral outcome measures, such as through developmental screenings or measures of stress hormones.

Video feedback interventions have been demonstrated as being an effective means of positively impacting adults' interactions with children and improving the trajectory of child development. For example, the Attachment and Biobehavioral Catch-Up video coaching intervention (Bernard et al., 2014) was reported to lower cortisol levels compared to a group who did not receive video feedback. These data suggest improved development of children's stress-regulation systems. Additionally, a meta-analysis of early childhood sensitivity and attachment interventions found that, in interventions geared toward improving parental sensitivity, video feedback interventions were more effective than those without video feedback (Bakermans-Kranenburg et al., 2003). Evidence that improving caregiver-child interactions also improves child brain development means that methods of quantitatively scoring interactions could be used to test new interventions designed to achieve this goal by comparing interactions before and after the intervention. To do this, researchers would need a method to quantify the most important aspects of parent-child interactions – *emotional connection, reciprocal contribution to interactions,* and *progressive challenges facilitated by adults* (Bronfenbrenner, 1979; Shonkoff & Phillips, 2000; Gunnar et al., 1996).

2.6 CURRENT METHODS FOR ANALYZING VIDEOS OF INTERACTIONS

Any intervention focused on behavioral observation needs a method of measuring interaction quality, either to correlate with other data, or to assess change longitudinally. Some researchers have developed such video scoring systems. Doing so reliably requires the quantification of the behaviors that constitute interactions. For example, scoring systems have been developed to measure *Synchrony*, which Gordon and Feldman (2008) define as "the temporal coordination of microlevel relational behaviors into patterned configurations that become internalized and … shape infant development." In a 2014 review of measures of mother-child synchrony, Leclère et al. identified nearly 60 measures aimed at assessing interactions between parents and young children ranging from newborns to 36-month-olds.

However, coding the behavior of infants and toddlers differs from coding the behavior of older children, aged three to six years old, because this older age group has a broader, more developed skillset: by 12 months, children often use pointing to communicate, though they sometimes begin to use words around this time. At 18 months, children are just beginning to understand the concept of "mine," and they usually use up to around 25 words. By 36 months, however, children typically develop creativity skills and the ability to describe the thoughts of others. Importantly, this is also around the age where many children begin to communicate in a much more complex way, putting together multiple sentences and having meaningful conversations (Scharf, Scharf & Stroustrup, 2016). Their social-emotional skills begin to develop rapidly (Gerber, Wilks & Erdie-Lalena, 2011; Scharf et al., 2016), so measures of their interactions with adults should reflect this. If scoring systems are to capture meaningful information based on dyadic interactions, they should focus on the ways that children 36 months and older communicate.

Some researchers have created scoring systems aimed at serving this purpose. Many of these scoring systems utilize an "overall" approach to coding videos: they provide one score across numerous interaction domains for the entire video. One study using this approach explored whether attachment in 12-month-olds is associated with behavioral outcomes in the same children at 42 months of age (Egeland & Hiester, 1995). Participants were asked to perform structured tasks that required maternal instruction. Coders scored the mother and child separately using seven-point scales of interaction qualities within these structured tasks, such as quality of maternal instruction, hostility, and child confidence. Another study was conducted to measure semi-structured mother-child interactions over a three-year period (NICHD ECCRN, 2003). This longitudinal study collected data when children were 36 months old, 54 months old, and in first grade. The scoring approach, which gave separate scores for mothers and children, looked at behavior domains such as support, hostility, mother's respect for child's autonomy, child enthusiasm, and affect. This scoring strategy has also been used to code interactions with children displaying developmental disabilities. One study correlated mother-child interactions with hyperactive and inattentive behaviors in three- to four-year-old children (Healey, Gopin, Grossman, Campbell & Halperin, 2010). The dyad participated in a structured task and in free play. Here, there were separate codes for the mother, the child, and the dyad. The researchers observed behaviors such as enthusiasm, emotional support, affect, and reciprocity of interactions

Other researchers have employed scoring strategies that allow for coding of individual behaviors as they occur, or separating videos into shorter intervals and giving a score for each. However, most of these scoring strategies have been applied to structured videotaped interactions, with the researchers providing participants with specific instructions regarding how to interact. One such study coded behaviors of mother-child dyads during situations of maternal instruction (Kochanska & Aksan, 1995). Depending on the task, videos were scored in 20-second to minute-long intervals. They were coded in terms of affect, maternal control, and children's compliance with parent directions. Whipple, Fitzgerald and Zucker (1995) studied whether parent-child interaction quality was related to family alcoholism. Children were three to six years old, and the videos consisted of three semi-structured activities: child-directed play, parent-directed play, and cleanup. Their scoring paradigm involved separate codes for parents and children – codes dealing with things such as affect, attention, social orientation, intrusiveness, and mother's support of child's autonomy. Scores were given every minute. Another group of researchers conducted two studies which they published together (Mize & Pettit, 1997). In the first study, videos were coded on an overall basis, whereas in the second study, videos were split into 30-second intervals. Mothers were asked to perform structured tasks with their three- to five-year-old children. In addition to measuring interaction style and maternal warmth, the authors investigated mothers' teaching styles. Using five-point scales, they scored behaviors relating to affect and mutuality within the interaction.

Finally, some of the scoring systems that score videos in intervals focus on a relatively narrow range of interaction qualities. Lindsey, Mize and Pettit (1997) coded interactions based on "mutuality" between parents and children ages 45 to 76 months. Mutuality was considered as a function of play style and compliance. The authors focused on instances of play initiations, in addition to using a five-point scale for synchrony, which they defined as “smooth and reciprocal behavioral exchanges,” over 30-second intervals. Another study correlated parent-child interaction quality with hyperactivity among preschool boys (47 to 62 months old) (Keown & Woodward, 2002). The researchers scored videos in 30-second intervals using five-point scales of synchrony and maternal commands.

These studies all share a major common strength: they used video to achieve quantification of adult-child interactions. Additionally, most provide sound justification for the use of their constructs as important indicators of interaction quality and child development. The goal of these scoring systems is to obtain a degree of information that is unobtainable through in-person assessment. However, each approach demonstrates at least one key limitation regarding the quantitative measurement of adult-child interactions. Some scoring systems give a single score for an entire video rather than splitting it into intervals or coding behaviors as they occur, which restricts specificity. Many of the scoring systems tend to focus on a narrow range of interaction qualities while overlooking important behavior domains that have been shown to support healthy development – for example, coding mutuality of interaction contribution while overlooking indicators of emotional affect. Some of the studies indicated low levels of inter-rater reliability among coders, and several of those with high inter-rater reliability utilized coders with significant expertise in the field of child development, which confines the use of these scoring systems to researchers with such expertise. Lastly, many of the videos recorded were of highly structured, controlled activities that may not be representative of how adults and children regularly interact.

Of the studies analyzing dyadic adult-child interactions, there is a lack of methodology for obtaining highly detailed behavioral assessment in all the important interaction domains. A single 10-minute-long interaction can exhibit immense behavioral variation, so coding specific behaviors, rather than coding the entire interaction or large intervals, conveys more information. The aspects of adult-child interactions that best support child development are *strong emotional connection*, *reciprocal contribution to interactions*, and *progressive challenges facilitated by adults* (Bronfenbrenner, 1979; Harrist, 1994; Kochanska, 2002; Cassidy & Shaver, 2016). Each of the extant measures captures some aspects of these domains, but none of them independently consider all the behavior domains that support child brain development. Though their principal aim is to provide coaching rather than to quantify behaviors, the Simple Interactions video feedback intervention (Akiva et al., 2016) utilizes each of these domains, which they refer to as Connection, Reciprocity, and Progression. In the Simple Interactions system, videos are scored in an "overall" manner to help guide the feedback process. Therefore, Simple Interactions provides an ideal foundation for the expanded, adapted scoring system described in this paper.

The new scoring system is designed in a way that reflects validated protocols for coding animal behaviors – namely nonhuman primates. These protocols allow for highly precise coding of specific behaviors (Cameron et al., 2003; Coleman, Dahl, Ryan & Cameron, 2003; Fawcett et al., 2014). In addition to comprehensively including the important behavioral domains, this scoring system can be used with high reliability among those who are not experts in child development or related fields. Therefore, any researcher investigating interaction quality could use this scoring paradigm to assess change in interactions over time.

2.7 AIMS

2.7.1 Aim 1:

Adapt the Simple Interactions scoring system to quantitatively measure 10-minute-long videos of interactions between parents and three- to six-year-old children, using the behavioral domains of *emotional connection*, *reciprocal contribution*, and *progressive challenges*.

2.7.2 Aim 2:

Assess the reliability of the quantitative scoring system.

3.0 METHODS

3.1 WORKING FOR KIDS EDUCATION INTERVENTION

Working For Kids: Building Skills (WFK) is a neuroscience-based community education platform aimed at teaching adults how to help improve children's social-emotional and cognitive skills. WFK received a grant to conduct a pilot study to measure whether providing parents with neuroscience-focused training has an impact on the developmental outcomes of their children. Training consists of four education sessions that use interactive, hands-on activities to teach parents how children's brains develop and how to facilitate sturdy brain development in their children. To investigate whether educating parents affects children's brain development, twenty-three children (3 to 5 years old) and at least one of their parents were recruited into the study. Data were collected at three time points: baseline (i.e. before parents received WFK training), six months after parent training, and one year after parent training. At each time point, data were collected from both parents and children. Parent data consisted of demographic information and past ACE exposure. Child data consisted of measures of cognitive development, sleep quantity and quality, social-emotional development, ACE exposure, demographic information, and physiological measures related to stress. One measure of social-emotional development was a video of parent-child free play. This scoring system was developed out of a need to reliably analyze these videos.

3.2 PARTICIPANTS

Twenty-three parents were consented at four of the Family Support Centers (FSCs) in Allegheny County. FSCs are community centers which offer free services, resources, food, and childcare to underserved families, with the majority of families served living at or below the poverty level. Most children in the FSCs are between the ages of zero to five years old; sixty three percent of parents have a high school education or less; more than half of parents are unemployed ("Family Support Parents and Children | Allegheny County Family Support", n.d.). FSCs offer preschool programs and “Kindergarten Readiness” programs. All participants were enrolled at their respective FSC location prior to recruitment to the study. A community partnership was established with the Family Support network and all data were collected on-site at the four FSCs.

At baseline, the age of the children ranged from thirty-nine months to sixty months old. The age of the parents ranged from twenty-two to forty-four years old. All but one of the parents participating in the WFK training were mothers. Of the children, there were eight boys and fifteen girls.

Participants were compensated for their contribution to the study. Parents received $40 for completing the four 1.5-hour sessions of WFK training. They also received $10 each time they completed a one-week sleep log for their children, indicating when their children went to bed, the number of times they awoke during the night and when they rose for the day.

In total, 22 videos were collected at baseline. One video was unable to be coded due to poor quality. Videos recorded at baseline ranged from five to eight minutes in length. 21 baseline videos and two videos recorded at the six-month follow-up (each five to 10 minutes in length) were used to assess reliability. A total of 23 unique videos were used.

3.3 PROCEDURE

3.3.1 Process of Collecting Videos

All videos were filmed on-site at one of four FSC locations. Since the FSCs are childcare settings, each had a wide variety of toys and activities for parents and children to choose from. The only instruction provided to parents was to play with their child as they normally would, using any toy or activity of their choosing. They were aware of being filmed, and the person conducting the filming would position him or herself in such a way as to be unobtrusive but to maximize the view of the participants' faces, as well as to remain close enough to pick up the sounds of the conversation. They were asked to minimize their interaction with any children other than their own. When possible, the dyad was filmed in a separate room away from other children.

The parents were not instructed to play with any particular toy or conduct any particular activity for two reasons. First, since the filming took place at four different FSCs, and since each FSC is equipped with different toys and activities, it was inevitable that there would be variation between videos. Second, to capture interactions that were as natural as possible, placing fewer constraints reduced the risk of stifling the children's enthusiasm by limiting the activity.

3.3.2 Description of Domains and Subdomains

The scoring system consists of three domains, as put forth by Simple Interactions:

Connection is defined as the degree to which the dyad is jointly engaged and displaying mutual outward affect. ***Reciprocity*** is defined as the degree to which a "balanced interaction between adult and child, neither dominating, but exhibiting an overall 'serve and return' type of exchange” is occurring. ***Progression*** is defined as whether the adult is facilitating opportunities for the child to learn through providing developmentally-appropriate challenge (Akiva et al., 2016). Within each of these domains, there are three subdomains – designated as X, Y, and Z – to indicate the quality of each domain, with X being the lowest and Z being the highest. For example, CX represents low Connection, CY represents moderate connection, and CZ represents high connection. Thus, there are nine total subdomains that make up the scoring system: CX, CY, CZ, RX, RY, RZ, PX, PY, and PZ. Figure 1 displays the visual representations of Connection, Reciprocity, and Progression from the Simple Interactions manual (taken from Akiva, Li, Julian, Galletta Horner & Martin, n.d.).

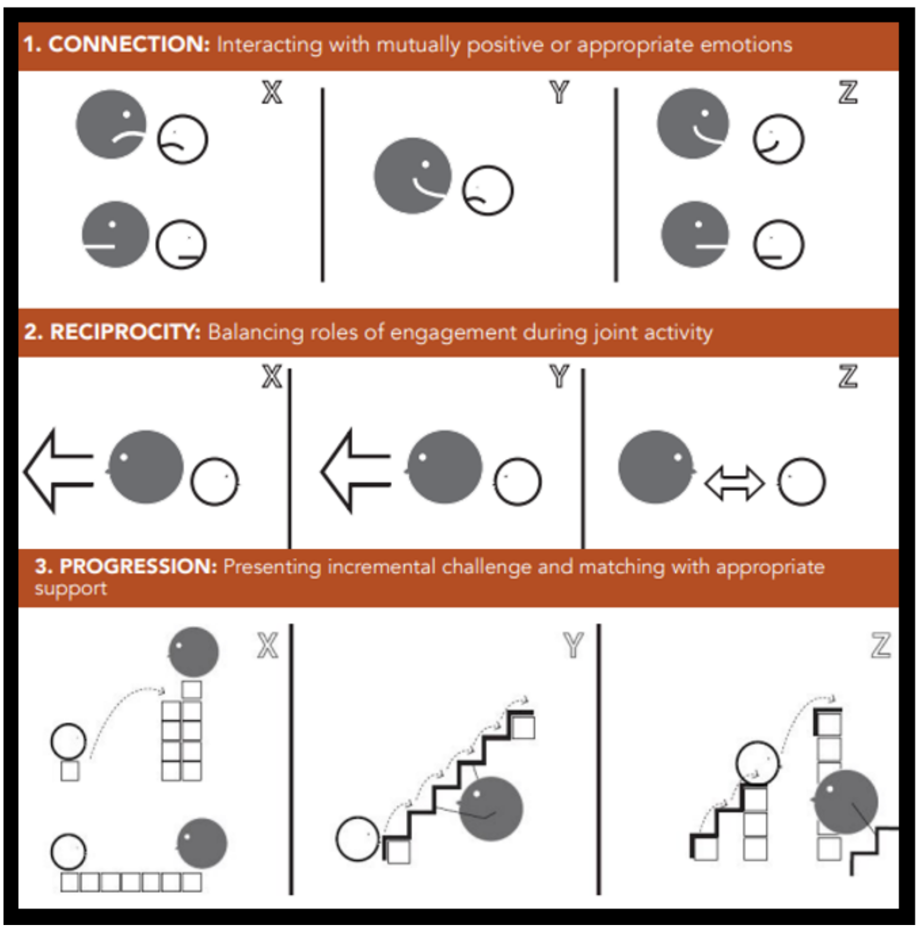

Figure 1: Original Simple Interactions Representations of Connection, Reciprocity, and Progression

3.3.3 Development of the Scoring System

The three behavioral domains, with three subdomains each, were already established by Simple Interactions for their video feedback system (Akiva et al., 2016). The Simple Interactions video feedback system also involves a fourth domain called Participation, which involves an adult's inclusion of multiple children in an activity. Since only dyadic interactions between one adult and one child were used here, Participation was excluded from the scoring system.

Videos were scored using The Observer computer program (Noldus, The Netherlands). The Observer is a video-coding software which can be used to precisely micro-code behaviors (coding behaviors the exact moment they occur). Videos are played within the Observer interface and coders can manipulate the video with standard controls: playing, pausing, fast forwarding, and rewinding as necessary. The Observer was configured with nine codes – CX, CY, CZ, RX, RY, RZ, PX, PY, and PZ – each corresponding to a keystroke on the computer. To code a behavior, the coder pauses the video the moment a behavior occurs and types the corresponding keystroke. Each new score is added to a list of scores displayed next to the video.

To gain further knowledge of the behavioral constructs, a partnership was formed with a member of the Simple Interactions research team. This added depth of understanding of the behaviors relevant to coding parent-child interactions (e.g. range of affect, communication patterns, play style, physical proximity, parent instruction). With this deeper understanding came the realization that it was necessary to make a list of salient behaviors to guide the coding process.

Videos were watched twice – once to code Connection and Progression, and again to code Reciprocity. Initial attempts at micro-coding videos resulted in substantial inconsistencies between coders. To guide the decision-making process of assigning subdomain codes, flowchart-style diagrams corresponding to each domain were created. This allowed for the mapping of the subdomains in a logical, step-by-step manner. Arriving at a final set of diagrams involved several iterations and revisions for each domain. Each iteration was assessed for reliability and revised if multiple coders consistently coded videos with high variability.

Throughout the process of creating the flowcharts, the Simple Interactions researcher would consistently review them and provide feedback. This researcher coded several of the videos in this project using the original Simple Interactions video feedback paradigm in order to make comparisons and maintain construct validity compared to the more qualitative version of the scoring method. Additional researchers from the Simple Interactions team – made up of experts in child psychology, child development, and education – also approved of the flowchart diagrams. In the final scoring system, Connection and Progression are scored on a moment-by-moment basis. As soon as a change in Connection or Progression occurs, the video is paused and a score is given at the exact moment of the change. Reciprocity is scored in 15-second intervals – since it is an interaction quality that necessarily happens over time, it must be scored in intervals rather than moment-by-moment.

3.3.4 Analysis

When a video is completely scored, The Observer stores the data in a text file that contains a list of each score given and its corresponding time stamp. Data can be exported from The Observer program into an Excel file after coding is completed. This file contains data for each video scored by each coder, with percentages of time spent in each subdomain. For instance, if exactly one minute of a five-minute video was coded as CX, then 20 percent of that video was CX.

Data analysis was performed using SPSS Version 22. To assess inter-rater reliability for Connection and Reciprocity, intraclass correlation coefficients (ICCs) (two-way mixed, absolute agreement) were run for subdomain percentages between coders. To calculate reliability for Connection, an ICC for each Connection subdomain – CX, CY, and CZ – was performed separately, for two coders. The procedure was the same for Reciprocity. Conversely, Progression is scored as *instances*, rather than as a percentage of the video. However, most videos contained no instances of Progression whatsoever, so Progression was excluded from further analysis.

Using subdomain percentages, composite scores were calculated to provide an overall score within the domains of Connection and Reciprocity. Percentage of X was multiplied by 1, percentage of Y was multiplied by 3, and percentage of Z was multiplied by 5. This calculation results in a number ranging from 100 to 500 indicating the quality of each domain. For example, a video with 15 percent CX, 32 percent CY, and 53 percent CZ would have a composite score of (15 + 96 + 265) = 376. ICCs were calculated for Connection and Reciprocity composite scores.

4.0 RESULTS

Table 1 displays the nine subdomain codes and summarizes their corresponding characteristics as they relate to our final flowchart diagrams. In this new scoring system, ***Connection*** refers to emotional affect and the level of engagement between the adult and child. Engagement can be established through conversation, gaze, physical proximity, and performed actions (e.g. play behavior). Affect is determined by facial expressions and tone of voice. ***Reciprocity*** refers to *mutuality* of engagement and contribution in an interaction and/or conversation. It reflects the "back-and-forth" nature of the interaction, assessing whether either the adult or child is dominating that interaction at any given time. Generally, Reciprocity builds on Connection. In other words, it is rare that a 15-second interval will receive a high Reciprocity score if most of that interval was coded for low Connection. Finally, ***Progression*** is a more advanced parenting skill which refers to the degree to which the adult is facilitating a challenge for the child, and if so, the degree to which the adult assists the child in arriving at a solution. For example, a parent might challenge his or her child to open the lid of a jar. At first, the child attempts to open the lid by pulling it off rather than twisting. The parent then asks for the jar and demonstrates how to perform a twisting motion. The parent hands the jar to the child, and the child successfully twists open the lid on his or her own. This would be an example of high Progression. Similarly to how Reciprocity builds on Connection, high Progression is more likely to occur during moments of high Reciprocity.

Each diagram consists of a step-by-step, guided decision-making process. To score Connection (Figure 2) at any given moment, the first thing the scorer asks is if the dyad is engaged whatsoever. If no, CX is coded. If yes, the scorer considers affect: if the adult and child are displaying mismatched affect, CY is coded. If both the parent and child are displaying positive affect, CZ is coded. If both are displaying negative affect, CX is coded. If both are displaying neutral affect, the scorer then considers if they are interacting in a joint activity together. If yes, CZ is coded. If no, the scorer considers if they are in close physical proximity. If no, CY is coded. If yes, the scorer considers if they are talking, touching, or looking at each other or looking at the same thing. If yes, CZ is coded; and if no, CY is coded.

Table 1: Subdomain Codes and Their Corresponding Descriptions

CODE	MEANING	CHARACTERISTICS
CX	Low Connection	Complete lack of engagement Mutually negative affect
CY	Moderate Connection	Mutual interaction without full engagement Mismatched affect
CZ	High Connection	Full mutual engagement Mutually positive affect
RX	Low Reciprocity	Complete lack of engagement Moderate engagement with little to no communication
RY	Moderate Reciprocity	Interaction being dominated by one person Full engagement in joint activity with little to no communication Moderate engagement with moderate communication
RZ	High Reciprocity	Full engagement in joint activity with moderate to high communication Equal contribution to conversation by both individuals
PX	Low Progression	No challenge from parent Challenge from parent beyond child's feasible skillset
PY	Moderate Progression	Appropriate challenge from parent where parent provides continuous help
PZ	High Progression	Appropriate challenge from parent where parent allows child to solve problem independently

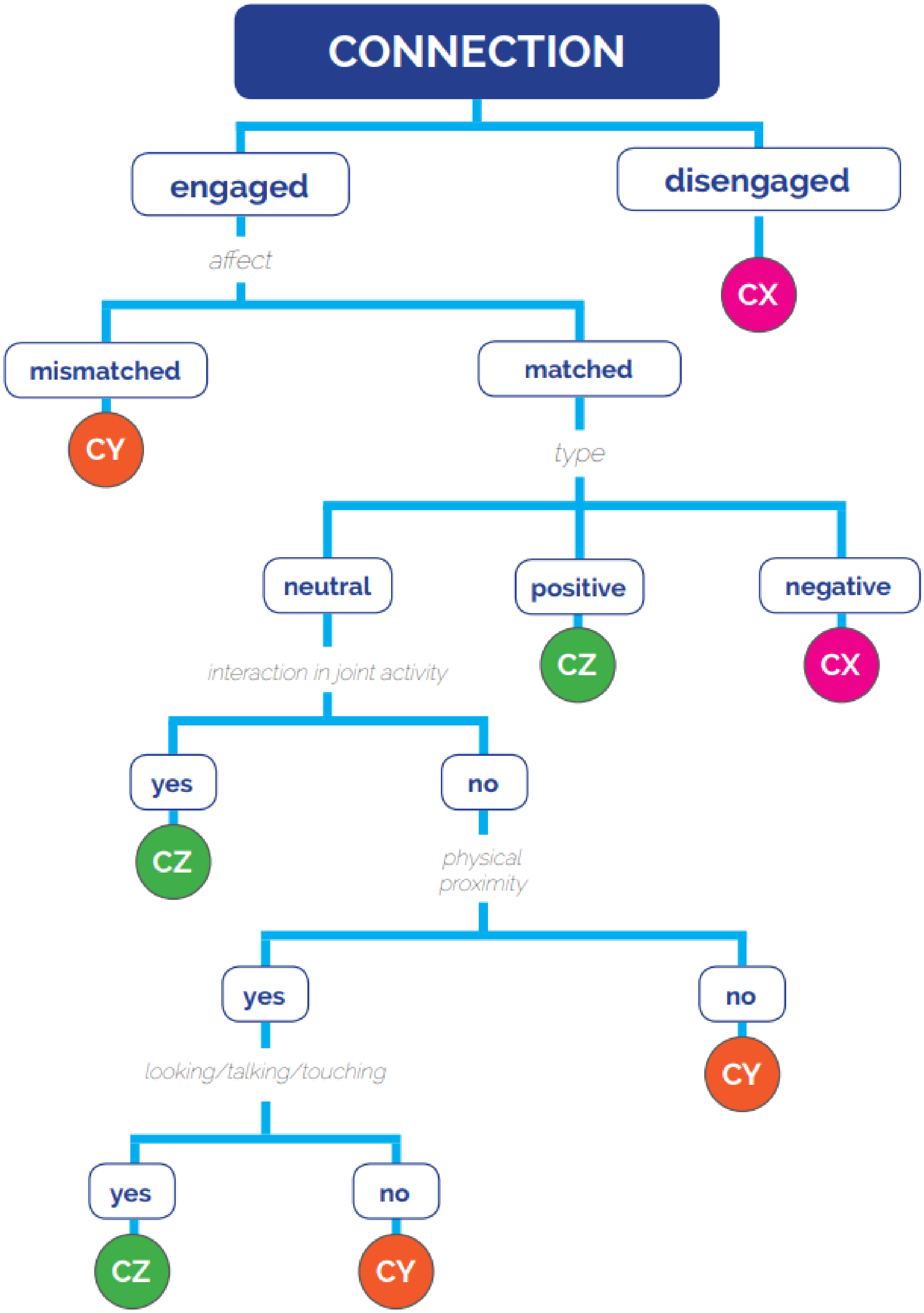

Figure 2: Connection Diagram

Reciprocity is scored in 15-second intervals. To score Reciprocity (Figure 3), the first step is to consider if the dyad is engaged whatsoever for the majority of the interval. If no, RX is coded. If yes, the scorer considers whether they are mutually interacting in a joint activity for the majority of the interval. If yes, the next thing the scorer considers is if one individual is leading the interaction. If yes, the scorer notes whether the non-leader is displaying appropriate contribution. If yes, RZ is coded. If no, RY is coded. If neither individual is leading, the scorer considers whether the dyad displayed mutual cooperation. If yes, RZ is coded. If no, RY is coded. If the dyad is not interacting in a joint activity for the majority of the interval, the scorer notes whether the dyad displayed significant communication. If yes, RZ is coded. If no, the scorer considers whether the dyad displayed verbal communication during the interval. If yes, RY is coded. If no, RX is coded. The terms appropriate contribution, mutual cooperation, significant communication, and verbal communication (among other terms) are defined in the Glossary (Table 2).

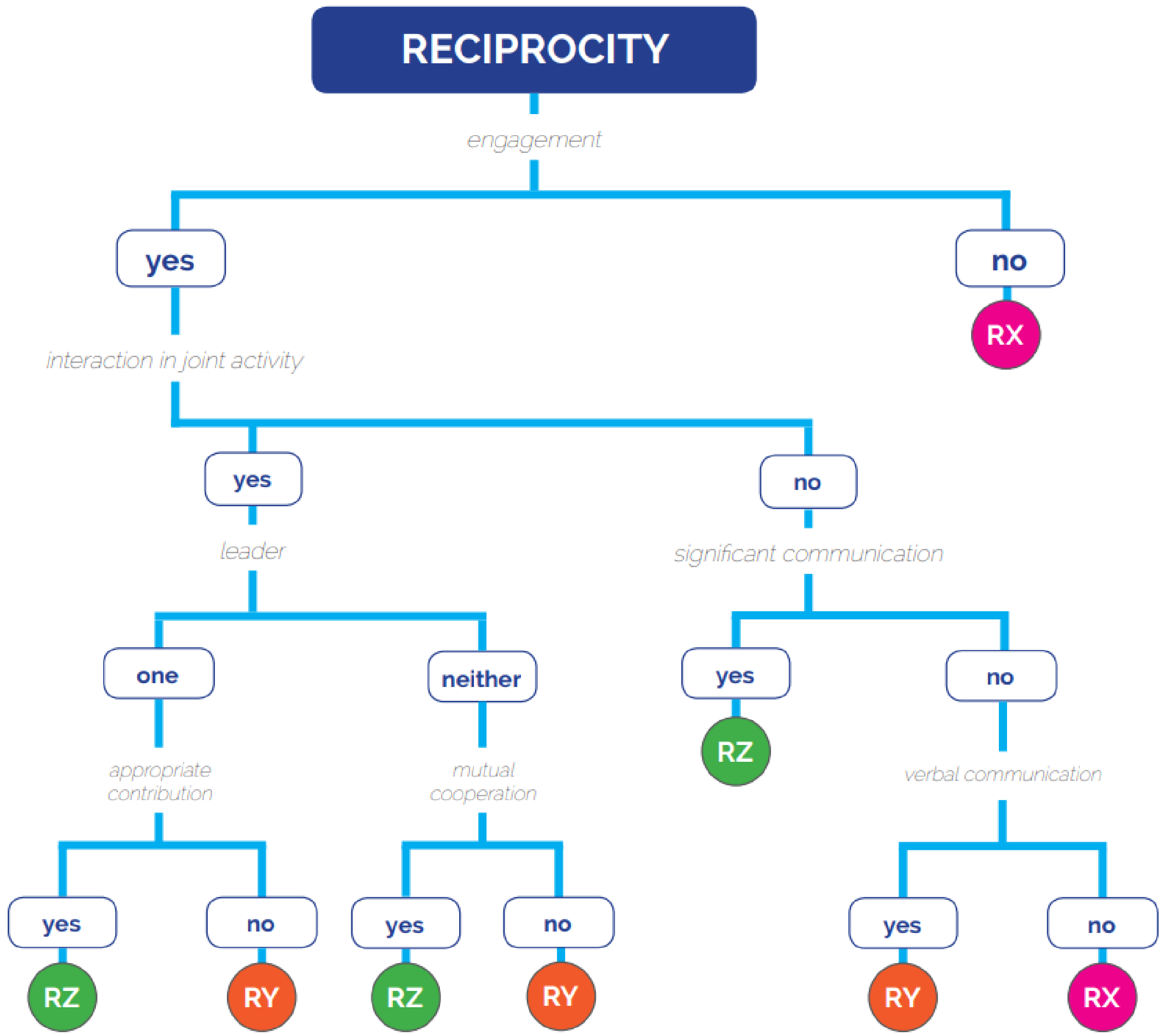

Figure 3: Reciprocity Diagram

Like Connection, scores for Progression are given as changes occur. To score Progression (Figure 4), the scorer first considers whether the adult is challenging the child. If there is no challenge, PX is coded. If there is a challenge, the scorer considers if the challenge is appropriate for the child (the scorer has a basic prior understanding of what is appropriate for this age group). If it is not appropriate (i.e. beyond reasonable), PX is coded. If there is a challenge, and it is appropriate, the scorer considers if the parent is *fading* (i.e. if the parent allows the child to solve the problem on his or her own). If the parent is fading, PZ is given. If the parent is not fading, PY is given.

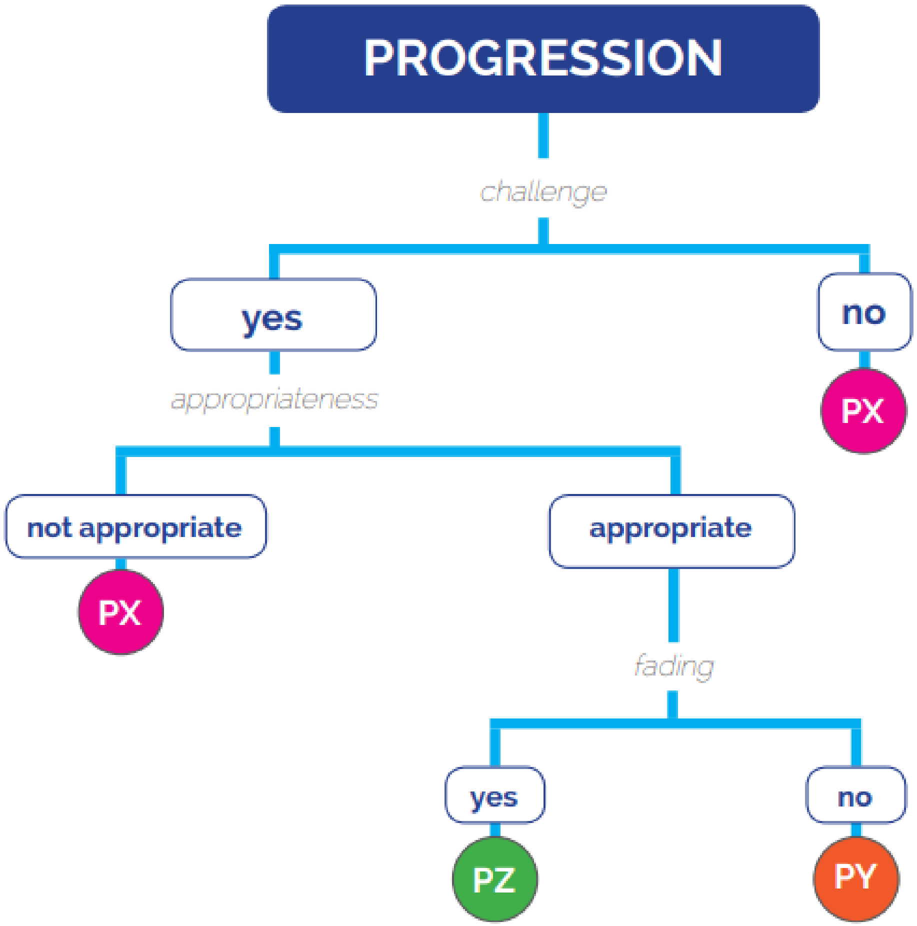

Figure 4: Progression Diagram

Table 2: Glossary of Terms

GLOSSARY
Affect - emotion shown by facial expression and tone. Categorized broadly as positive, negative, or neutral affect.
Appropriate contribution - designation that happens when an activity has a leader (either parent or child) and the other participant contributes and elaborates on the activity. When the non-leading participant is a parent, he/she is considerate of the child's pace and demonstrates patience.
Appropriateness - a challenge is deemed appropriate when enough support has been given for a child to succeed. An inappropriate challenge is above of the abilities of the child at that moment.
Challenge - a task or situation that stretches a child's abilities.
Engagement* - a meaningful verbal or non-verbal contact has been established between parent and child.
Fading - the parental act of providing an appropriate challenge, offering scaffolding, but then removing that scaffolding while remaining supportive so that the child has the freedom to meet the challenge in their own way.
Interaction in joint activity* - both participants are physically engaged in the same activity while close together. Proximity is required except when the activity necessitates distance (e.g. playing catch).
Leader* - one participant is responsible for determining the direction of the activity through commands or by choosing a new activity.
Mutual cooperation - two serve-and-return exchanges, regardless of who serves.
Physical proximity - participants are within arm's reach of each other and are on the same physical level.
Significant communication - at least two full serve-and-returns. Each participant must serve at least once.
Verbal communication - Two serve-and-returns, both from the same person; OR One serve-and-return; OR Two serves regardless of who serves.
Serve - An initiation of communication that adds new information to the exchange. Often this is in the form of a question, but any initiation of communication that adds new information is a serve. Examples: "What should we play with now?" "This is my favorite puzzle." "Let's go over there."
Return - A basic response to a serve. A question of clarification, or asking someone to repeat what they said, counts as a return, not a serve.
* For Reciprocity, this must take place for the majority of the 15-second interval.

Table 3 displays ICCs for Connection and Reciprocity between two coders (IEM and MLL). Subdomain score percentages in this table are rounded to the nearest whole number, but ICCs were calculated using percentages with two decimal places. Subdomain ICCs were as follows: CX: 0.95, CY: 0.81, CZ: 0.87, RX: 0.97, RY: 0.76, RZ: 0.86. Connection composite ICC was 0.90, and Reciprocity composite ICC was 0.94. As mentioned previously, Progression was excluded from analysis due to insufficient data to calculate reliability.

Table 3: Subdomain Percentages, Composite Scores, and Intraclass Correlations for Connection and Reciprocity

		Connection				Reciprocity			
Video	Coder	CX	CY	CZ	Comp	RX	RY	RZ	Comp
		%	%	%		%	%	%	
1	IEM	0	36	64	428	37	34	29	286
	MLL	10	44	46	372	44	41	15	241
2	IEM	7	16	77	438	33	29	38	310
	MLL	10	29	61	402	28	49	23	291
3	IEM	0	9	91	482	26	57	17	280
	MLL	0	7	93	485	17	52	32	330
4	IEM	0	10	90	479	2	20	78	451
	MLL	0	11	89	478	0	37	63	426
5	IEM	0	15	85	469	25	42	33	317
	MLL	0	23	77	454	12	37	50	375
6	IEM	20	34	46	353	40	46	15	249
	MLL	25	37	38	325	44	45	11	235
7	IEM	0	10	90	480	5	49	46	381
	MLL	0	13	87	475	8	36	56	398
8	IEM	0	12	88	477	51	44	5	208
	MLL	1	34	65	429	55	40	5	200
9	IEM	0	4	96	492	10	35	55	390
	MLL	0	19	81	461	17	45	37	340
10	IEM	0	18	82	463	10	53	37	355
	MLL	0	24	76	453	10	19	71	422
11	IEM	0	4	96	491	10	57	33	347
	MLL	0	7	93	487	14	53	33	338
12	IEM	0	11	89	478	2	69	29	353
	MLL	0	11	89	477	7	48	45	375
13	IEM	1	10	89	476	0	42	58	417
	MLL	1	16	83	464	7	53	39	364
14	IEM	14	23	64	399	69	26	5	174
	MLL	12	41	47	371	70	27	3	165
15	IEM	0	3	97	493	10	21	69	419
	MLL	0	10	90	480	15	35	51	372
16	IEM	0	3	97	494	0	55	45	390
	MLL	0	11	89	477	5	50	45	380
17	IEM	0	19	81	462	0	48	52	404
	MLL	0	21	79	457	8	52	40	366
18	IEM	0	17	83	466	3	74	23	342
	MLL	0	27	73	446	5	75	20	330
19	IEM	3	45	51	396	48	46	6	216
	MLL	1	25	74	446	33	50	17	268
20	IEM	0	6	88	455	6	74	20	329
	MLL	0	9	90	480	15	70	15	300
21	IEM	0	14	86	472	0	63	37	374
	MLL	0	13	87	475	5	49	47	384
22	IEM	0	8	92	484	4	50	46	383
	MLL	0	5	95	489	8	58	33	350
23	IEM	0	3	97	495	0	50	50	399
	MLL	0	6	94	488	0	45	55	410
	ICC	0.95	0.81	0.87	0.90	0.97	0.76	0.86	0.94

5.0 DISCUSSION

We created a video scoring system that can be used to quantitatively code dyadic interactions between parents and three- to six-year-old children. The coding scheme consists of three decision-making flowchart diagrams that expand on the constructs in the Simple Interactions tool – constructs that have been shown to positively impact brain development. Behaviors are coded as they occur, using either moment-by-moment coding, or short intervals when necessary. This allows for a detailed, in-depth view of the interaction quality based on a distribution of percentages of time coded as low, high, and moderate quality within each domain.

A unique feature of this scoring system is that it acknowledges all behaviors as taking place within a broader context. For example, if a serve-and-return exchange occurs, it matters what the dyad were doing up to that point – whether they were already interacting in a play activity together, or whether one of them was leading the interaction – simply observing a serve and return is not enough information to give a definitive score. This principle is true in all of the diagrams. The decision-making process being mapped in this way adds an important layer of detail that is not present in other scoring systems. In addition, this new tool is accessible for a wide range researchers, and unlike many other scoring systems, can be used reliably by those with little to no experience in child development or child psychology. For this reason, any study investigating interaction quality in this age group could feasibly adopt this scoring tool.

Evidence suggests that there are certain features of adult-child interactions that characterize supportive relationships and facilitate healthy development in children (Bronfenbrenner, 1979; Harrist, 1994; Kochanska, 2002; Mashburn et al., 2008; Cassidy & Shaver, 2016). It is imperative that researchers have methodology to quantitatively assess the degree to which interactions are attaining ideal standards. Due to the complexity of dyadic interactions, especially with children aged three to six, the most effective way to do this has been with video observation (Kochanska & Aksan, 1995; Egeland & Hiester, 1995; Whipple et al., 1995; Mize & Pettit, 1997; Lindsey et al., 1997; Keown & Woodward, 2002; NICHD ECCRN, 2003; Healey et al., 2010). However, each of the current methods available demonstrates at least one limitation, as characterized by (1) lack of a comprehensive behavior set (2), lack of specificity in the coding system such that one code is given for an entire interaction, (3) reliance on having a scorer with expertise in child development, or (4) low inter-rater reliability. This new coding paradigm addresses the limitations of the current methods in that it (1) captures a comprehensive range of interaction qualities that support brain development, (2) scores behaviors as they occur rather than scoring an entire video, (3) does not require intensive training, and (4) can be used with high reliability even when scored by those who are not experts in the field of child development.

Through addressing the limitations found in other video-scoring approaches, this scoring system not only considers the most important adult-child relationship characteristics, but it does so in a way that conveys a high degree of specificity. Some scoring approaches sacrifice detail to capture a wide range of behaviors; other approaches sacrifice important behaviors to obtain more detail. In other words, some sacrifice depth for breadth; others sacrifice breadth for depth. Due to its design, this scoring system sacrifices neither one.

5.1 LIMITATIONS

Humans have natural, sometimes unavoidable, often unrealized biases which can taint their judgments and performance. This scoring system is susceptible to biases, both on the part of the researchers and the participants. It is designed such that behaviors themselves are scored, rather than overarching qualities, which greatly reduces subjective judgment. However, using the diagrams entails some subjectivity because the behaviors can sometimes be difficult to interpret (for example, determining whether someone is smiling; or if a command should be considered as “leadership”). In addition, there is the possibility of the dyad “performing” for the camera. In other words, the videos may be a biased representation of how parents usually interact with their children. It is likely that this is at least partially mitigated by having recorded the videos on-site at the FSCs. The families are familiar with the FSC setting and they are often surrounded by friends, so it is expected that the behaviors they demonstrated in the videos generally reflect the way they normally interact. In addition, the videographers spent time building rapport with the parents and children before beginning the videotaping so as to increase the likelihood of the dyad demonstrating natural behavior even in the presence of relative strangers.

Dyadic interactions are highly complex, and any scoring system will inevitably lose some of that complexity in its attempt to reduce interactions into something that can be scored in a quantitative manner. This scoring system generally uses 10-minute-long videos (though many of the videos collected at the beginning of the study and described in this paper were somewhat shorter). A 10-minute video does not capture the entirety of a parent-child relationship. However, the tool has enough depth to capture the important information about adult-child interactions while remaining practical in terms of time required to code an entire video. It would be possible to determine how much video footage would be needed to more fully represent the adult-child relationship. This could be accomplished by recording several videos, and assessing how much video footage must be scored before there is no further significant variation in score by adding more video footage. Such strategies are often used in behavioral studies in animals. For example, studies in nonhuman primates in which normative behavior coded in a social living situation is scored have indicated that at least two hours of video footage must be scored before a reliable assessment of the percentage of time a monkey spends in any one behavior can be obtained (J. Cameron, personal communication, April 2018).

Lastly, although use of this scoring system does not require expertise or an advanced degree, it does require a moderate amount of training. Coders must learn how to use The Observer software, as well as the terms in the glossary and their proper application. Coders must also familiarize themselves with what sorts of challenges are appropriate for the three- to-six-year-old age group (asking a child for the color of a puzzle piece is not challenging; asking the child to perform double-digit addition is too challenging). In other words, it is not expected that a layperson could immediately begin scoring videos after one day of training. However, it is reasonable to assume that any member of a research team could learn how to properly score videos within several weeks.

5.2 FUTURE DIRECTIONS

Since so few instances of Progression occurred in these videos, it was impossible to test the Progression diagram for inter-rater reliability, so validation of the Progression diagram must take place in a future study. Anecdotally, it seems that the follow-up videos taken one year after the WFK training sessions in the current pilot study appear to display more instances of Progression than at baseline, so it may be possible to use the data from these follow-up videos to assess the Progression diagram.

Overall, there are several ways in which this coding system can be used in the future. The first is video analysis. In this approach, videos will be coded, and interaction quality will be correlated with other measures or assessed longitudinally. The flowchart diagrams described in this thesis were developed for an ongoing research project, of which one aspect is to longitudinally evaluate parent-child interaction quality over a one-year period post-WFK educational training. The scoring system will be used in this longitudinal study, as well as other longitudinal studies that the lab is currently initiating. It could likely be used in any study investigating interactions between adults and children aged three to six years old, but it could be adapted for interactions taking place in many different contexts. In fact, two teams of researchers familiar with this work have developed adaptations of the flowchart diagrams for their own use (e.g. Liu, 2018). Each of these studies involves videos recorded under different conditions from the videos used here – one study uses a group setting, and the other uses structured activities. In addition to adaptations, the use of these diagrams by other researchers in their current state would help further validate them.

Another potential use for this scoring system is as an evaluation tool. In this context, the aim would be to gather data on programs' performance over time. For example, early childhood programs could implement annual or semi-annual video-taping of enrolled children interacting with the program staff. The videos could be used to measure the quality of the staff's interactions with the children, which would provide valuable information regarding the staff's competency and the program's overall effectiveness.

This scoring system could also be used in video feedback interventions. As described previously, the aim of adult-child video feedback interventions is to identify examples of ideal behaviors, show those examples to the adult, and encourage that sort of behavior in the future. Since this adaptation maintains the original subdomains of X, Y, and Z from Simple Interactions, researchers could easily identify high-quality behaviors, coded as CZ, RZ, and PZ. The researchers would show the footage to the adult and explain that acting in this way helps children's brains develop in a healthy way.

Finally, researchers and practitioners could use the coding scheme as a screening assessment. Certain developmental disorders are characterized by specific symptoms relating to social interactions. For example, it may be possible to adapt these diagrams to reflect the symptoms of a disorder such as autism. The adaptations would be developed by a team of experts who study autism, and the diagrams would be designed in such a way that they detect behaviors that typically characterize autism. Just as with other screening tools, children displaying troublesome symptoms could be referred for further care.

6.0 CONCLUSION

In conclusion, this thesis describes the successful adaptation and expansion of a video-based scoring system which can reliably be used to quantify a breadth of critical interaction qualities that support child brain development. This measurement system could be used in any research setting geared toward studying children's social-emotional development. Additional studies utilizing this coding scheme would further validate its uses and applications.

The implications for this scoring system go beyond simply inferring the overall quality of an adult-child interaction. Growing up in adversity can hinder development and cause a vast number of negative health outcomes. Healthy relationships with caring adults can mitigate the effects of adversity, facilitate the acquisition of key skills, and support optimal development among children. Therefore, being able to quantify interactions and specify their quality provides data that can be used to improve outcomes for children living in adverse circumstances. If researchers can effectively measure interaction quality, and evaluate how often high-quality interactions are occurring, they can identify the programs and interventions that have the greatest impact on interactions. With this information, the most effective programs can be more widely implemented, and the others can be modified. Here, the cliché "knowledge is power" is apt: through understanding interactions more deeply, it is possible to continue to strengthen children's development through healthy relationships.

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