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# Use of non-referential gestures in Canadian-English speaking children between the ages of 5 and 9 years

by

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## Abstract

Hand gestures are an integral part of human communication (Gullberg et al., 2010). Research has demonstrated that referential (those that reflect meaning) gestures, begin to develop before a child reaches one year of age, and plays an important role in language acquisition (Vila-Gimenez & Prieto, 2021; Rohlfing et al., 2017). However, this link has been less established for non-referential (those that do not reflect meaning) gestures, also referred to as beats. Therefore, the aim of this study was to investigate the use of non-referential gestures in Canadian-English speaking typically developing children aged 5 to 9. Patterns of use of beat gestures were examined through a story retelling task. It was determined that children aged 5 to 9 used beats with adult-like characteristics; i.e., with well-defined stroke phases. Additionally, the children used more beats when compared to referential gestures. Younger children (5.0-6.11) were seen to use referential gestures more frequently with content than function words, while older children (7.0-8.11) used beats with both function and content words. However, these developmental trends were not substantiated by statistical analyses. These outcomes could suggest that children aged 5-9 years have not yet formed a clear link between the use of gestures with spoken output. Findings from this study leave avenues for future research to identify how beat gestures align with spoken output across a range of discourse tasks and populations.

# Table of Contents

Chapter Page

## List of Tables

Table Page

## List of Figures

Figure Page

## Chapter 1: Introduction

Human communication is accomplished through use of linguistic and para-linguistic codes with various means of transmission, i.e., through speech, gestures, and whole-body language. Language or the linguistic code is a socially shared code or conventional system which represents concepts through the use of arbitrary symbols and rule-governed combinations of these symbols (Owens, 2011); while speech, the verbal means of communication, is the result of precise neuromuscular coordination. The other aspects of communication that enhance the linguistic code are classified as paralinguistic, non-linguistic, and metalinguistic codes (Owens, 2011). Paralinguistic components include intonation, stress, pause, and rate of delivery, which are superimposed on the speech signal. Metalinguistic skills are those abilities that enable an individual to analyze, judge and talk about language, thus signalling the success of communication. Hand gestures, facial expressions, body movements, body postures, head movements and proxemics are considered the non-linguistic code.

Hand gestures (referred to as gestures from here) are clearly not random movements; these are movements used to communicate. They are visual and spatial phenomena that are influenced by contextual and socio-psychological factors that are closely tied to complex speaker-internal, and linguistic processes (Gullberg et al., 2010). It is hypothesized that there never is a true distinction between verbal and gestural communication, since spoken language is universally accompanied by gestures and the synchrony between the two behaviours is controlled by the same neural system (McNeill, 1985). Kelly et al. (2010) consider speech and gesture as two sides of the same coin since gestures and speech mutually enhance comprehension in either of the two modalities. It is also presumed that, just like verbal language, gestures are acquired from exposure to the gestures used by a linguistic or cultural community.

**Factors that influence the use of gestures**

Like language, gestures are most likely acquired from being exposed to gestures used by a community. McNeill & Duncan (2000), studied the gestures of English, Spanish and Chinese speakers and observed that speakers differed in the way they verbally and gesturally described motion events. Another study, that investigated cross-linguistic differences between English and Turkish speakers, reported that gestures produced during spoken language productions by English speakers were different from those produced by Turkish speakers (Özçalışkan et al., 2016). However, the authors found no cross-linguistic differences in the gestures that were produced without the spoken component, suggesting that speakers do not always rely on language-specific gestural patterns.

According to Tellier (2009), gender is a factor in development of gestures, since studies on nonverbal communication have shown differences between males and females, such as the way arms and legs are displayed, the way people sit, stand or walk (Rekers et al., 1981). Feyereisen & de Lanoy (1991), have observed that nonverbal behaviours can even reflect the personality of an individual. Verbal skills and levels of proficiency have also been hypothesized to have an effect on the way someone gestures, both in first and second language acquisition (Gullberg, 1998; Sherman & Nicoladis, 2004; Yoshioka & Kellerman, 2006). Professional skills are also said to have an influence on the gesture style of an individual (Calbris, 2003).

**Gestures in adults**

Kendon (1988) proposed a classification, called the Kendon's continuum, which has four types of gestures on the continuum: gesticulation, pantomime, emblems and sign language. This classification system is based on the premise that some gestures are closely linked to spoken language while others are not (McNeill, 2005). The former includes gesticulations, which are

spontaneous movements of arms and hands that accompany speech (McNeill, 2005). Gestures that do not align with speech can include emblems, pantomime, or signs. Emblems refer to conventional signs, such as a thumbs-up, that are well-known throughout a culture (McNeill, 2005). These differ from pantomimes, which are sequences of gestures conveying a narrative line, or telling a story without accompanying spoken output (McNeill, 2005). Finally, sign languages are distinct linguistic systems, such as the American Sign Language, that are used by a community of users (McNeill, 2005).

Another way to categorize gestures is by considering their ability to align closely with various aspects of spoken language, which include semantics, prosody and even discourse (McNeill, 1992). Based on this categorization, iconic, deictic and metaphoric gestures are 'referential', because they resemble aspects of the semantics, whereas beats are abstract and 'non-referential' because they do not convey semantic meaning and are often identified based on their movement characteristics. An *iconic* gesture is one that presents an image of an action or entity (McNeill, 2005). This means that the gesture itself carries semantic meaning in the same way that spoken language does. An example of an iconic gesture could be flapping one's arms to represent a bird's wings, or making the movement of swinging a baseball bat.

*Metaphoric* gestures are similar to iconic; however, they present an image of an abstract concept (McNeill, 2005). These gestures carry meaning, but are movements or handshapes that do not match a concrete object or action. An example of a metaphoric gesture could be holding out one's arms in a movement to portray the weighing of options. A much simpler form of gesture is *deictic*. These are usually pointing action of index finger, palm or other body parts when the hands are preoccupied (McNeill, 2005). All the aforementioned gestures differ from *beat* gestures, which are considered hand movements that do not present discernable meaning

(Kendon, 2004). Beats typically align with the rhythm of speech (McNeill, 2005), and are assumed to serve an emphatic function during discourse, i.e., they stress the important words or phrases while speaking (McNeill, 1992; Igualada et al., 2017). An example of a beat would be a flick of the hand or finger. However, it must be noted that the movement characteristics of beats have been variably delineated. To account for this variability, Prieto and colleagues (2018) have suggested that beats are hand gestures which cannot be classified as iconic, metaphoric, or deictic.

***Gesture phases***

When people gesture, their hands typically move in succession. These successions or gesture phases are the different movement phases observed during the execution of gestures (Kendon, 1980; McNeill, 2005; Bressem & Ladewig, 2011). The first phase is *preparation*, where the hand moves away from its resting position and into the gestural space (Kendon, 1980). This often leads to the second phase which is the *stroke*. The stroke refers to the body of the gesture, and is the segment that holds meaning for the listener. This third phase leads into a *retraction* or *recovery*, where the hand moves back into a rest position. It is important to remember that the retraction phase does not always involve the hands returning to the same position in which they began, and also does not always occur, as the speaker may immediately move to a new stroke. In addition to these phases, there may be sections where movement cessation can be observed, and these are labelled *holds*. Holds can occur prior to or after the occurrence of the stroke (McNeill, 2005).

***Function of gestures in adults***

Traditionally, gestures are said to function as communicative devices. Kendon (1994) observed that gestures play a part in communication and provide information to listeners about

the semantic content of the utterances. Dittmann & Llewellyn (1969) suggested that sometimes gestures may be used as random movements to dissipate tension during lexical search, because people often gesture while having difficulty retrieving an elusive word from memory and hand movements may provide a means for reducing this tension. Other investigators have observed similar functions but they have not attributed this to tension management (Butterworth, 1975).

Since gestures are common when speakers try to access words from their lexicon, it has been suggested that they play a direct role in retrieval of lexical units (Freedman, 1972; Werner & Kaplan, 1963). However, support for this notion is again inconclusive. Graham & Heywood (1975), analyzed the speech of five speakers who were prevented from gesturing as they were required to describe abstract line drawings, and concluded that exclusion of gestures did not have any particular effect on speech. On the other hand, Rimé (1982) and Rauscher et al. (1996) reported that restricting gestures adversely affected speech. For example, it has been demonstrated that people who suffer from chronic stuttering exhibit similar lapses of gesture during their pauses in speech due to a stutter (Mayberry et al., 1998). Gestures have also been linked to be a help or hindrance based on the type of lexicon being retrieved. For instance, Beilock and Goldin-Meadow (2010) found that the use of gestures that are compatible with an action required to complete a task will cause an increase in performance. This study also demonstrated the opposite effect; i.e., the use of gestures that were incompatible with an action caused a decrease in performance on a task (Beilock & Goldin-Meadow, 2010). Therefore, gestures may play a role in either characterizing a spoken lexicon or a mental representation, and in either case have shown to likely have a positive effect on task outcomes.

Gestures are also found to enhance learning in educational settings. For example, a study by Kastens and colleagues (2007) demonstrated that adult students are more successful in their

learning when taught with gesture enriched discourse. They noted that when teachers use gestures, the gestures helped focus students' attention on salient details of a subject, as well as to refocus attention when switching between cues (such as from lecture to a diagram or photograph) (Kastens et al., 2007). Further, this study demonstrated that the use of gestures by students can facilitate better learning outcomes, and that educators can enhance the use of gestures by creating opportunities for the students to speak during class and providing situations in which gestures are a natural outcome. Similar findings by Roth (2001) as well as Atit et al. (2015) suggests that the integration of gestures into education can be a critical factor in students' ability to learn.

**Gestures in children**

Repetitive motor activities of young infants towards the end of the first year of life, especially of the hand, begins to pave the way for mature and articulated control of hand movements which eventually leads to directed gestural communication. Infants begin to communicate intentionally, initially through hand gestures, then vocalizations and even later with words. Gestures and spoken language are considered equal partners, since most often the symbols produced by children are expressed in both modalities, i.e., gestural and vocal (Gullberg et al., 2010). Some studies indicate that gestural and vocal modalities are semantically and temporally integrated from the earliest stages (Capirci et al., 2005), while others report that asynchronous combinations of gestures and speech are more frequently produced than synchronous ones, in the initial development period (Butcher & Goldin-Meadow, 2000).

First among the gestures that children acquire are referential gestures, and are often deictic in nature (Bates et al., 1979). For instance, infants often point to objects before they are able to label the object with a word. This is followed by iconic gestures around 12 months of age, which also coincides with the first use of words (Bates et al., 1979). Next, children aged 9 to 13

months use requesting gestures such as grasping motions (Bates et al., 1979). These are followed by the use of representational gestures, such as mimicking holding a glass, that are used when children have a vocabulary of around 25-words (Tellier, 2009). Children between the ages of 12 and 18 months begin to use gesture and spoken language in a more separated manner, with one being used more frequently than the other. Iverson and colleagues (1994) demonstrated these findings in a study of 16-month-old children. They found that at 16 months children have developed a preference for either gesture or spoken language, and then at 20 months there is a significant increase in spoken words (Iverson et al., 1994). This use of referential gestures in children has been shown to lead to the development of adult like gesture-speech patterns. Children begin by using gestures in a way that is asynchronous to speech, and later produce gestures and words that combine for a single meaningful utterance (Butcher & Goldin-Meadow, 2000). As infants develop into toddlers, their use of gestures becomes more elaborate and integrated into their speech. Iconic gestures begin to increase when children reach ages 3 to 5, and are most frequently at this age before metaphoric and beat gestures become established. As children reach the ages between 5 and 6, metaphoric and beat gestures emerge. Colletta (2004) demonstrated this in a quantitative study on children aged 6 to 11. His findings align with that of McNeill (1992) who noted that metaphoric and beat gestures emerge after the age of 5 years. Beat gestures have been found to emerge in young children coinciding with the onset of longer utterances. Mayberry and Nicholadis (2000) demonstrated this in their study on French-English bilingual children aged 2 to 3.5 years. These findings further indicate that gesture and spoken language are related rather than independent.

Children are indeed found to demonstrate the integration of gesture and spoken language as a communicative unit from an early age. During infancy, children produce communicative

gestures often without spoken language (Tellier, 2009). Gestures seem to correspond more with spoken language as a supplemental agent. Iverson and colleagues (1994) in their study of children aged 16 months have found that they (children) show a preference for either words or gestures; however, by the age of 20 months children prefer spoken words over gestures (Iverson et al., 1994). The integrated production of gestures with spoken language coincides with the age when children produce two-word utterances (Goldin-Meadow, 1998). This integration continues throughout childhood and ultimately leads to the characteristics of gestures and spoken language typically seen in adult communication. Most recently, a study by Pronina et al. (2023) examined the correlation between the use of gestures and narrative scores in children aged 3 to 4 years in a story retelling task. Although their findings indicated that gesture rate did not correlate with high narrative scores, these authors found a positive correlation between narrative scores and gesture accuracy (while reproducing gestures that were introduced to them).

### *Functions of gestures in children*

The development of gesture in children is considered a predictor of language development and can provide a signal for the emergence of spoken language (Iverson & Goldin-Meadow, 2005; Özçalışkan & Goldin-Meadow, 2005). Further, gestures have been found to allow children to express ideas that are still forming because gestures represent knowledge visually without the demand of formulating a verbal description (Goldin-Meadow, 2003). Research has also shown that adults can glean information from a child's gesture, and they often tailor their instruction to the child according to what they believe is the child's understanding (Goldin-Meadow & Singer, 2003). In the same vein they report that, the child's gesturing sets up opportunities for the adult to model spoken language that labels what the child is gesturing, thus aiding in language development.

Several studies also suggest that the gestures children produce while speaking reveal much more about what they are thinking than what is reflected solely in their speech (Goldin-Meadow et al., 1993). Investigations on gesture production in school-aged children in problem-solving tasks, reasoning about balance or mathematical equivalence, problem-solving strategies etc. indicates that children convey a substantial proportion of their knowledge through speech-accompanying gestures (Goldin-Meadow et al., 1993; Beaudoin-Ryan & Goldin-Meadow, 2014; Church & Goldin-Meadow, 1986; Pine et al., 2004). In some other instances, children's gesture-spoken language 'mis-matches' may predict learning. Children whose speech and gestures mismatch are more likely to benefit from instruction than children whose speech and gestures match (Goldin-Meadow, 2011). This interesting finding suggests that spoken language and gesture can serve as an index of transitional, implicit knowledge in a topic, and may help determine a child's 'readiness to learn'. This claim aligns with research done in education, which suggests that teachers can better interpret a student's work by taking note of their gestures that align with the student's underlying understanding of a topic (Fennema et al., 1996).

Gestures have also been suggested as an effective learning tool in the classroom to help children understand mathematical concepts (Novack et al., 2014) and verbs (Hall et al., 2022). Furthermore, it has been demonstrated that children with spoken language impairments use gesture to compensate for limitations or immaturities in articulatory or linguistic skills (Acredolo & Goodwyn, 1988; Iverson & Thelen, 1999). As these gestures can be beneficial to the learner, so too can they be beneficial to the child's parents, teachers, etc. Gesture use can demonstrate a child's access to information that they are cognitively aware of but cannot verbally produce (Goldin-Meadow, 2000). These findings further demonstrate the important function of gestures in learning.

As can be seen, the role of gestures in spoken language acquisition and development changes in different stages and depends on the communicative/interactional contexts. By one year of age, gestures aid in the construction and expression of meaning (Bates et al., 1979). In the following stages, gestures and spoken language develop together (Iverson et al., 1994). At later stages, gesture production appears to decrease in certain contexts (e.g., naming), although it is frequently used with spoken language in others (e.g., narration); nevertheless, gesturing never disappears and continues well into adulthood. However, it must be noted that while there is a large body of work that demonstrates the acquisition and function of referential gestures (e.g., iconic, deictic) in young children, the development of non-referential gestures in children have not been extensively investigated.

***Non-referential gestures (beats) in children***

As noted, limited studies have documented the acquisition of beats in young children. Among these, some studies have focused on understanding the use or production and functions of these gestures in children. It should be noted that there is considerable variation in the use of beats across ages and across studies, potentially due to the types of discourse tasks used as well as possible linguistic influences. One such study by Nicoladis et al. (1999) longitudinally studied five French-English bilingual boys, in Canada, through the ages of 2 years to 3 years 6 months. Data collected across both languages was used to determine the rate of gesture production and the alignment of gesture production with spoken language. Results indicated that iconic and beat gestures are linked to the development of language at the age of 2 years old, while other gestures such as pointing are not (Nicoladis et al., 1999). Also, since the study included bilingual children with language abilities that differed in both the languages, the authors noted a link between

iconic and beat gestures and language proficiency. They concluded that gesture use positively correlated with language proficiency.

Another study by Igualada et al. (2017) found that children aged 3 to 5 years old, who speak Catalan, used beat gestures to highlight words therefore stimulating word recall. The participants were asked to recall a list of words presented during a story retelling task. The researchers presented some of the target words accompanied by beats, and some without, to understand the impact of gestures on recall. Children were mostly found to recall words that were accompanied by beats (Igualada et al., 2017). Although these results indicate beats can facilitate word recall in children, it should be noted that the gestures were accompanied by facial and head movements, that occurred spontaneously, and these may have influenced the outcome. The authors also noted that the discourse task used was familiar to the age group of participants being tested, which could also have impacted the results.

Colletta et al. (2010) studied the use of gestures in 120 French participants across three age groups, 6-year-olds, 10-year-olds, and adults to determine the effect of age and gender on language complexity, discourse construction, and gesture use (Colletta et al., 2010). Gestures were categorized as deictic, representational, performative, framing, discursive, interactive, and word searching (Colletta et al., 2010). In this study beat gestures were categorized as discursive, i.e., brief gestures that accentuated or highlighted certain linguistic units of speech. The results of the study indicated that gesture use was not influenced by gender; however, it was found to be influenced by age. It was seen that adults gestured significantly more than the 10-year-olds, who were subsequently found to use gestures significantly more than the 6-year-olds while narrating the story (Colletta et al., 2010). The authors concluded that gesture use in children correlated

with language complexity, as well as discourse construction, which could then suggest that use of beats is dependent on the linguistic abilities of children.

Vila and Prieto (2020) examined the relationship between beat gestures and narrative story retelling in Catalan-Spanish bilingual children aged 5 and 6. They collected data using a pre-test/post-test format. During the pre-test each participant watched a short clip of a cartoon and then was asked to retell the story to the experimenter (Vila & Prieto, 2020). The post-test occurred in the same manner, with the children watching a different cartoon. A training session took place between the two tests, during which the children watched a video of a person telling a story with the use of beat gestures, and were then asked to retell the story. The results indicated that encouraging children to use beats by making comments such as, "Look at the farmer and watch how she moves her hands when she's telling you the story", improves their narrative abilities (Vila & Prieto, 2020). However, the authors also hypothesized that these effects could be short-term, and further research is needed to expand these outcomes to understand long-term effects.

Mathew and colleagues (2018) studied beats, which were defined as stroke-defined non-referential gestures, in six-year-old Australian-English speaking children. Participants were children in the age range of 5 to 7 years who completed a story re-telling task and an exposition task (Mathew et al., 2018). Data from the two tasks was analyzed to determine the type of gestures used, the frequency of use, and their alignment with spoken language. Results showed that only 9 of the 12 participants used stroke-defined beat gestures, and these children produced mostly gestures of referential nature in both of the discourse tasks. The use of gestures types did not differ between the two discourse tasks. In the study, children who spoke more (measured as the number of utterances), were also found to frequently use both referential and beat gestures.

Additionally, beat gestures were observed to co-occur with lexical words (e.g., nouns); however, these words were not always pitch-accented. The authors concluded that unlike adults, children are not using beats for the purpose of emphasis during discourse (Mathew et. al., 2018). The results of the study could have been influenced by the discourse tasks that were used. For example, in this study the caregivers asked probing "wh" questions during the expository task, which may have prompted the children to use less planning in their responses and this in turn would have influenced their gesture use.

In a recent study, Florit-Pons et al. (2023) examined the patterns of gesture-speech alignment, i.e., alignment of pitch-accented syllables and gesture strokes, in children in the age ranges of 5-6 and 7-9 years in a narrative retelling task. The findings revealed that both referential and non-referential gestures aligned with pitch accented syllables by the young age of 5-6 years, and that there are no differences between the two types of gestures in this regard (Florit-Pons et al., 2023). Additionally, it was seen that the use of non-referential gestures increased significantly with age, which suggests that these gestures align with the complexity of narratives that children produce as they mature.

Additionally, one study compared the use of beats in children and adults. Shattuck-Hufnagel and colleagues (2016) examined beats in both adults and children (six-year-olds) to determine the characterization and functions of beat gestures. Gestures used by adults were studied using video recordings of academic lectures, while those used by children were studied using a narration task. The results demonstrated that adults produced more beats than children, and children produced more referential gestures when compared to adults. Nevertheless, it was seen that beats in children and adults exhibited all gesture phases. This indicates that beats are characterized by complex phasing components, including the obligatory stroke phase, as well as

the optional ones such as preparation, hold or recovery. Further, the authors found differences in the functions of these gestures between the groups. Adults' gestures aligned with the prosodic structure of accompanying spoken utterances, while the same was not observed for children. This suggests that beats could be considered prosodic gestures in adults, while the gestures could perform prosodic and additional discourse functions in children. However, it should be noted that the adults and children were not involved in the same discourse tasks, which could have influenced the types of gestures that were produced by both groups of participants.

Two studies have investigated the relationship between beats and cognitive-linguistic processes and have provided inconclusive findings. Llanes-Coromina and colleagues (2018) studied both comprehension and recall in Catalan-Spanish bilingual children in order to understand the functions of beat gestures. Four-year-old children were given three different story narration tasks. The tasks were different from each other, with one promoting both speech and gesture, one promoting only speech, and one with non-prominent speech. These tasks occurred after the participants had been primed with a preliminary word recall task in which they repeated a list of words produced by the experimenter. Findings indicated that the children recalled words that were accompanied with beats at a higher rate, however, these results may be limited by the task. For example, the target words that were selected closely aligned with the children's age, interests and abilities. In the same study, a second set of children, aged 5 and 6, were presented six narratives produced with differing placement of prosodic prominences and beat gestures. Participants watched videos of stories that were narrated by preschool teachers, after which they were asked two questions. Children were found to have better comprehension for stories that were accompanied by beat gestures. These results suggest that beat gestures can enhance children's word recall and comprehension skills. However, the results only demonstrate the

short-term effects of experimentally manipulated conditions and may not reflect real-life scenarios where the co-occurrence of gestures with components of spoken language could considerably vary.

The same effect was not seen in a different study by Austin and Sweller (2014) which examined the impact of gestures, both referential and beats, during the recall of spatial information. Children (3-4 years) and adults were randomly assigned to one of three conditions which involved the verbal presentation of route directions: representational gesture, beat gesture, or no gesture. Participants were then asked to recall routes. It was found that children, and not adults, had better recall of routes that were accompanied by representational gestures. This study concluded that beat gestures do not play a role in the encoding of spatial information.

**Statement of Purpose**

As noted in the aforementioned literature, gestures are integral to the development of communication in childhood. Gestures are considered cognitive bootstrappers since they can contribute to changes in linguistic knowledge with age (Goldin-Meadow, 2009). Recent research has also demonstrated that gestures are linked to both speech perception and production, providing further support to the notion that both modalities are a well-integrated communicative system (Kelly et al., 2010; McNeill, 1992).

A lot of emphasis has been laid on the role of referential gestures in language acquisition (Vila-Gimenez & Prieto, 2021). Typically developing children start using referential gestures, specifically deictic gestures, between the ages of 9 and 12 months, and these gestures help children carry out successful interactions with their caregivers (Rohlfing et al., 2017). They are also considered reliable predictors of future language skills, both in typically developing children and those with communication disorders (Butcher & Goldin-Meadow, 2000). Around the age of

one year and beyond, there is a significant increase in the use of iconic gestures which help children represent information about a referent in spoken language (Acredolo & Goodwyn, 1985; Iverson et al., 1994). Between the ages of 2 and 3 years, non-referential gestures, also known as beats, emerge. These gestures serve as rhythmic highlighters and align with pragmatic and discursive meanings which helps structure oral discourse in children (Prieto et al., 2018). It should be noted that the literature on the acquisition of these gestures is sparse. However, the general consensus is that children produce more beats with age, and this coincides with their use of complex linguistic skills such as narratives (e.g., Igualada et al., 2017; Kendon, 2017; Mathew et al., 2018).

Therefore, the aim of the present study was to understand the use of non-referential gestures in Canadian-English speaking typically developing children between the ages of 5 and 9 years. The study also documented the use of referential gestures in these children in order to compare the patterns of use between the two types of gestures. The patterns of use of both these gestures and the co-occurrence of these gestures with components of spoken language, such as content words (e.g., nouns), were also compared. Additionally, the study examined factors that could influence the use of non-referential gestures, such as age or quantity of spoken output (e.g., number of utterances). Therefore, the children in this study were divided into two age groups, 5.0 – 6.11 years and 7.0 – 8.11 years, in order to understand the differences in beat gesture use between these younger and older children.

Apart from these, there are several other questions that remain unanswered in our understanding of the acquisition of beats. One reason for this is because not all studies have defined or characterized beats in a similar manner. For example, Nicoladis et al. (1999) defined beats as meaningless, biphasic, up-down movements of the arms that have an emphatic function.

In contrast, Colletta and colleagues (2010) classified beats along with other referential gestures that served to highlight linguistic units or mark discourse cohesion by linking clauses. This variability could make it difficult to understand the movement characteristics of beats, phases and their linguistic role. Therefore, this study identified beats as intentional or purposeful movements that do not reflect contextual meaning, and were characterized by a well-defined stroke, the obligatory phase of the gesture (Yasinik et al., 2004).

Additionally, the function of beats in children has been poorly understood. However, most studies (e.g., Florit-Pons et al., 2023; Mathew et al., 2018; Colletta et al., 2010) agree that, like referential gestures, the use of beats aligns with the development of narrative and discourse skills. In a study of typically and atypically developing children aged 6-7 years, Blake et al. (2008) reported that beats were most likely to occur with noun phrases, verbs or prepositional phrases, suggesting that beats tend to co-occur with lexical categories, i.e., content words. Mathew et al. (2018) also found similar results in their study of 6-year-old children, in that, beats were found to co-occur with lexical words. The current study also intended to document the functions of beats in relation to parts of speech.

Therefore, the present study aimed to explore the following research questions:

Will Canadian-English speaking children in the age range of 5-to-9 years engaged in a story retelling task;

1. Use non-referential gestures with adult-like characteristics, i.e., gestures with well-defined stroke phases, and demonstrate the influence of age and spoken output in the use of non-referential gestures?

   Hypothesis: Here the assumption was that most children in the age range of 5-to-9 years would produce beat gestures that could be identified by their well-defined stroke phases.

It was also assumed that children in the age range of 7.0 to 8.11 years would use more beat gestures than children in the age range of 5.0 to 6.11 years, and that beat gesture production would positively align with utterance production.

2. Use non-referential gestures more with content words (e.g., nouns, verbs) when compared to function words (e.g., determiners, connectives)?

   Hypothesis: Here the assumption was that beat gestures would co-occur more with content words than with function words, similar to patterns established for referential gestures.

# Chapter 2: Method

## Participants

The participants of this study included 25 typically developing children between the ages of 5-9 years who primarily spoke Canadian-English. Following approval from the St. Cloud State University Institutional Review Board, the researcher began the recruitment process. Two school divisions in Manitoba, Canada, were contacted regarding participation in the study since these divisions were familiar to the researcher on account of a prior working relationship with one of the schools in these divisions. The Brandon School Division consists of schools in and around Brandon, Manitoba, and includes a total of 20 early-years schools. Following approval and recommendations from the school board committee, schools were contacted to participate in the study. A total of 5 schools were contacted, however only 2 agreed to support recruitment efforts.

The researcher contacted first and second grade level teachers in the schools and electronically shared the study information with them. The teachers were instructed to contact parents through email with information regarding the study. The email communication included a recruitment flyer with details of the study (see Appendix A), a demographic questionnaire (see Appendix B), and caregiver consent (see Appendix C). The demographic information collected from families included the age and known gender identity of the participant, race/ethnicity of the participant, participant and family history of communication disorders, languages spoken in the home, and number of family members in the home. Families interested in permitting their child to participate were asked to complete the demographic questionnaire and consent form prior to their child's participation. These forms were sent home with their children, and a physical copy was returned to their teacher.

A total of 34 caregivers consented to participate in the study and completed the questionnaire. Based on the questionnaire, only 25 participants met the inclusion criteria for the study, and therefore, 9 potential participants were excluded. For participants to be included they had to meet the following criteria: a) be within the age range of 5.0 to 8.11; b) primarily speak Canadian-English at home; c) have no known (current) conditions affecting language use; d) and have no known conditions affecting sensory abilities such as hearing or vision loss. Among the participants, 11 were in the age range of 5.0 – 6.11 years, 5 boys and 6 girls, and were a part of participant group labelled 'X'. The remaining 14 participants were in the age range of 7.0 – 8.11, 7 boys and 7 girls, and were a part of participant group labelled 'Y'. It must be noted that the ages of two of the participants in group Y were not shared by their caregivers, and their inclusion in the study was based on their enrollment in the school grade year, which coincided with the age range of interest in the study, i.e., 7.0 – 8.11 years. All demographic information and health and family history for participants is summarized in Tables 1 & 2, respectively.

**Task**

All participants were required to complete a story re-telling task. This task has been previously demonstrated to elicit gestures in school-aged children in the presence of either a caregiver or a researcher (Colletta et al., 2010; Mathew et al., 2018; Florit-Pons et al., 2023). The story re-telling task involved each participant watching a 2-minute cartoon video clip. The clip was titled "Keeping the Peace" a Shaun the Sheep episode (Aardman, n.d). This video clip consisted of only visual stimuli, background music, and sound effects, with no speech occurring. The main premise of this video is a farm dog attempting to keep other farm animals quiet as the farmer is asleep. The dog goes around the farm shushing animals in order to keep them quiet. The other animals attempt to make loud noises, such as cheering, blowing a trumpet, and letting

air out of a hot water balloon. Throughout the video the dog manages to keep the animals quiet and the farmer remains asleep while they play in the yard.

**Table 1**

**Participant demographics*

| **Participant** | **Age** | **Gender** | ***Primary Language** | **Percentage Secondary Language** | **Race/Ethnicity** | **# of family members in home** | **# of years in school** |
|---|---|---|---|---|---|---|---|
| **X1** | 5:5 | F | English | Yoruba 50% | Black/Nigerian | 4 | 2 |
| **X2** | 6:7 | F | English | N/A | White | 3 | 2 |
| **X3** | 5:10 | F | English | Amharic 20% | African | 6 | 1 |
| **X4** | 6:6 | F | English | Gujarati 6% | Indian | 3 | 2 |
| **X5** | 5:7 | F | English | Gujarati – no percent provided | East Indian | 4 | 1 |
| **X6** | 6:10 | F | English | N/A | Black | 4 | 4 |
| **X7** | 5:9 | M | English | Gujarati 30% | Hindu/Indian | 4 | 1 |
| **X8** | 6:2 | M | English | N/A | White | 4 | 1 |
| **X9** | 6:0 | M | English | N/A | White | 4 | 1 |
| **X10** | 6:10 | M | English | N/A | White | 5 | 2 |
| **X11** | 6:9 | M | English | N/A | White | 4 | 2 |
| **Y1** | 7:3 | F | English | N/A | White | 3 | 2 |
| **Y2** | 8:2 | F | English | Gujarati 40% | Canadian/East Indian | 4 | 3 |
| **Y3** | 8:1 | F | English | Mandarin 50% | Chinese | 5 | 3 |
| **Y4** | 7:8 | F | English | Spanish – no percent provided | Spanish/Native | 4 | 3 |
| **Y5** | 7:7 | F | English | Amharic 20% | Black | 6 | 3 |
| **Y6** | 7:3 | F | English | N/A | White | 3 | 2 |
| **Y7** | 7:3 | F | English | N/A | White | 3 | 2 |
| **Y8** | 7:2 | M | English | N/A | Indigenous | 6 | 3 |
| **Y9** | 7:1 | M | English | N/A | White | 5 | 2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Y10** | No data provided | M | English | Yoruba – no percent provided | Nigerian | 4 | 4 |
| **Y11** | 7:3 | M | English | N/A | White | 4 | 2 |
| **Y12** | 7:4 | M | English | N/A | White | 2 | 2 |
| **Y13** | 7:0 | M | English | N/A | White | 4 | 2 |
| **Y14** | No date provided | M | English | N/A | White | Not provided | Not provided |

**Note*. The 2021 census data of the city of Brandon estimates that only 77% of the population reported English as their mother tongue, which suggested that it would be difficult to control for cultural and linguistic influences with this small study sample (Population Statistics, Charts, Map and Location, n.d.).

**Table 2**

*Participant health and family history*

| Participant | History of hearing impairment | History of familial hearing impairment | History of motor impairment | History of speech-language impairment | History of visual impairment |
|---|---|---|---|---|---|
| **X1** | No | No | No | No | No |
| **X2** | No | No | No | No | No |
| **X3** | No | No | No | No | No |
| **X4** | No | No | No | No | No |
| **X5** | No | No | No | No | Wears glasses |
| **X6** | No | No | No | No | No |
| **X7** | No | No | No | No | No |
| **X8** | No | No | No | No | No |
| **X9** | No | No | No | No | No |
| **X10** | No | No | No | No | No |
| **X11** | No | Yes | No | No | No |
| **Y1** | No | No | No | No | No |
| **Y2** | No | No | No | No | No |
| **Y3** | No | No | No | No | No |
| **Y4** | No | No | No | No | No |
| **Y5** | No | No | No | No | No |
| **Y6** | No | No | No | No | No |
| **Y7** | No | No | No | Yes – received therapy for articulation errors | No |
| **Y8** | No | No | No | No | No |

| | | | | | |
|---|---|---|---|---|---|
| **Y9** | No | No | No | Yes – received therapy for language delay | No |
| **Y10** | No | No | No | No | No |
| **Y11** | No | No | No | No | No |
| **Y12** | No | No | No | No | No |
| **Y13** | No | No | No | No | No |
| **Y14** | No | No response | No | No | Wears glasses |

**Procedure**

Participants completed the task in a quiet and well-lit room in the school, with only themselves and the researcher present. Care was taken to ensure that the participants were comfortable before the initiation of the data collection, with the researcher engaging in small talk. Prior to the data collection the researcher administered the assent protocol (see Appendix D) to ensure that the participant expressed their assent to complete the task.

Each child viewed the cartoon clip on a computer, with the researcher seated facing away from the screen. They were informed that they could watch the clip multiple times until they felt comfortable telling the story to the researcher. The majority of participants viewed the video only once. After viewing the video, participants were asked to narrate the story to the researcher. The participant was seated on a chair facing the researcher and they were video and audio recorded using a video camera (Sony HDR) with a built-in microphone. Participants were encouraged to narrate the story on their own, with the researcher only responding with fillers and subtle prompts, e.g. ‘I agree’, ‘what else’, ‘tell me more’. Following this, the researcher asked probe questions in order to elicit a richer narrative from all the participants. Five questions were used as prompts, and were as follows:

1) Why does the sheep not want to wake the farmer?
2) How does the dog keep the other animals quiet?

3) What happens when the pig blows into his trumpet?
4) What game are the sheep quietly playing?
5) Do the farm animals stay quiet enough for the farmer to keep sleeping?

## Coding

All participant samples were analyzed using ELAN (Lausberg & Sloetjes, 2009) & PRAAT (Boersma & Weenink, 2022) software systems in order to annotate gestures and spoken output, respectively. A total of 25 participants completed the narrative task, but only 17 were included in the final analysis. 6 participants, 3 from X group and 3 from Y group, were excluded due to lack of gesture production throughout the sample, and 1 participant from X group was excluded due to poor intelligibility of the audio sample. The following coding schemes were used to address the research questions.

### *Gestures*

Gestures were analysed using ELAN software (Lausberg & Sloetjes, 2009). In the first stage of the analysis, the researcher viewed the video samples without audio input. Firstly, all the hand movements of the right- and left- hands were coded. Secondly, for each movement, gestural phases were identified. The phases that were identified were: 1. the preparation phase (beginning of gesture), 2. the stroke phase (meaningful movement), 3. the recovery phase (return to rest position), and 4. the hold phase (pause in movement). Each of these phases is integral to the gesture, although the stroke phase is considered the most effortful or meaningful phase of the movement (McNeill, 1992). Hand movements that did not have a well-defined stroke phase were not included in the data analysis, and these were labeled as non-purposeful movements. As a result, 16 hand movements (5 from group X, and 11 from group Y) were not included in the analysis.

In the second stage of the analysis, the audio input was turned on, and the researcher coded the types of gestures. The type was determined based on the presence or absence of contextual meaning; therefore, gestures were identified as either referential or non-referential, based on the presence or absence of semantic meaning, using McNeill's classification system (1992). Referential gestures included iconic, deictic, and metaphoric gestures, and non-referential gestures included beats. The characterization of the different types of gestures used in the study were (McNeill, 1992; Mathew et al., 2018):

a) Iconic: hand movements and shapes that reflect a one-on-one relationship with the semantic content of spoken utterances, e.g., flapping one's arms to represent a bird's wings.
b) Metaphoric: hand movements and shapes that reflect abstract relationship to the semantic content of spoken utterances, e.g., holding out one's arms, with open palms, in a movement to portray the weighing of options.
c) Deictic: pointing movements that indicate or locate entities and actions in space, usually using the index finger, palm, or other body parts when the hands are preoccupied, e.g., moving one's index finger up to specify an upward location.
d) Beats: intentional hand movements that have a well-defined stroke phase, and the movements do not reflect the meaning that is conveyed in spoken utterances they accompany, e.g., sharp up and down movement of hand that accompanies a word.

***Spoken output***

All audio recordings were extracted from the video and transcribed using PRAAT (Boersma & Weenink, 2022) software. The spoken output was transcribed as utterances and words, using speech waveforms, auditory cues and spectrographic information. An utterance was

defined using the following criteria (Mathew et al., 2018); 1. the continuous presence of spectral and intensity information within the potential utterance unit, and 2. The absence of any acoustic energy with presence of unfilled pauses at the beginning and end of the potential utterance unit. Following the transcription of utterances, word boundaries for every word in the utterance were coded. Periods of silences were labeled as pauses.

***Co-occurrence of gestures and spoken output***

For this level of analysis, the transcribed PRAAT files were imported to the corresponding ELAN file for each sample. The words that co-occurred with gesture strokes, of both referential and non-referential gestures, were identified. These words were then labeled as either a content or a function word. Content words were identified as those that possess semantic content such as nouns, verbs, and adjectives. Function words were determined to be those that do not contain semantic content and act as fillers and connectors, such as “and” or “the”. Stroke phases that did not align with words were identified as either occurring with a pause or noises produced by the participant (e.g., animal sounds).

***Inter-rater reliability***

The gesture and spoken output coding was carried out for all samples, separately, by two experienced coders, which included the researcher. Two other coders, one for gesture data and the other for spoken output data, independently recoded 10% of the participant data that were randomly assigned to them. Percent agreement for the coders was calculated. Reliability was 84.74% for the identification of gestures, and was 86.36 % for the identification of utterances.

***Data analysis***

Shapiro-Wilk test of normality was conducted in order to determine if the data (number of gestures and utterances) was normally distributed for the two age groups of participants. The results indicated that the data for both number of gestures and utterances met the normality

criterion, and subsequently, parametric tests were used to analyze the data. Alpha was set at 0.05 for all analyses.

## Chapter 3: Results

This study investigated the use of non-referential gestures, also known as beats, in Canadian-English speaking typically developing children between the ages of 5 and 9 years. It aimed to compare (1) the pattern of use of beats with that of referential gestures, (2) the influence of variables such as age and spoken output, and (3) the patterns of co-occurrence of these gestures with components of spoken language. The participants in this study were divided into two age groups for comparisons, 5.0 – 6.11 (mean: 6;2 years) years and 7.0 – 8.11 (mean: 7;5 years) years, and they were asked to complete a story retelling task. The findings related to all the research questions are as detailed below.

**Research question 1**: Will Canadian-English speaking children in the age range of 5-to-9 years use non-referential gestures with adult-like characteristics, i.e., gestures with well-defined stroke phases, and demonstrate the influence of age and spoken output in the of use of non-referential gestures?

It was seen that all children who participated in the study used gestures. Among the 18 children who participated in the study, 14 children produced beats and all children produced referential gestures. Among a total of 693 gestures produced by the children, 30.74 % were referential gestures and 69.26% were beats. Additionally, all beats produced by the children met the criterion of having ‘well-defined stroke’ phases. This suggests that Canadian-English speaking children in the age range of 5-to-9 years used beats with adult-like characteristics. However, it was also clear that there were individual differences in the production of both types of gestures (see Table 3).

Further analyses were performed in order to determine if there were variations in the patterns of use of gestures as a function of age. For this purpose, the children were divided into two groups, i.e., group X (5.0 – 6.11 years) and group Y (7.0 – 8.11 years). Table 3, presents the

number of referential and non-referential gestures produced by the children in the study. As can be seen, children in both groups produced more beat gestures (group X=65.32%; group Y=72.70%) when compared to referential (group X=34.67%; group Y=27.29%) gestures, consistent with the findings listed in the above paragraph. However, these were not supported by the subsequent statistical analyses that were run.

**Table 3**

*Number of gestures and utterances produced by children during story re-telling task.*

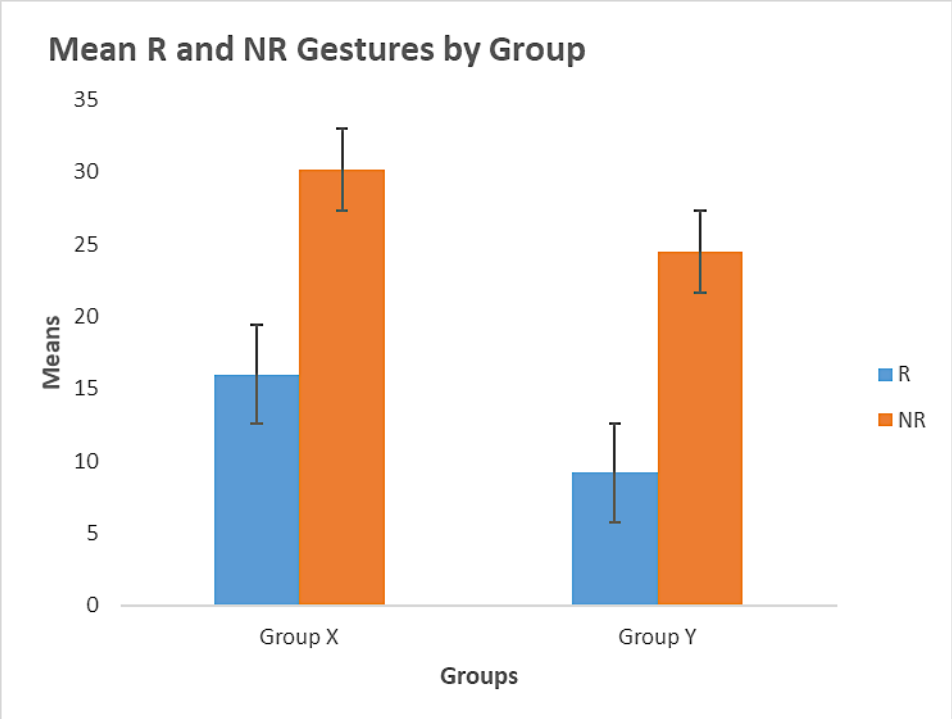
| Group X | | | | Group Y | | | |
|---|---|---|---|---|---|---|---|
| Participant | **Referential gestures** | **Beats** | **No: of utterances** | **Participant** | **Referential gestures** | **Beats** | **No: of utterances** |
| X2 | 17 | 0 | 34 | **Y2** | 10 | 11 | 52 |
| X3 | 3 | 2 | 23 | **Y3** | 32 | 79 | 92 |
| X5 | 24 | 71 | 18 | **Y4** | 19 | 78 | 99 |
| X6 | 6 | 0 | 58 | **Y6** | 10 | 9 | 100 |
| X8 | 1 | 0 | 15 | **Y7** | 2 | 11 | 25 |
| X10 | 30 | 113 | 31 | **Y9** | 4 | 2 | 82 |
| X11 | 31 | 25 | 48 | **Y10** | 1 | 2 | 35 |
| | | | | **Y11** | 1 | 0 | 17 |
| | | | | **Y12** | 1 | 2 | 35 |
| | | | | **Y13** | 7 | 5 | 45 |
| | | | | **Y14** | 14 | 70 | 43 |

In order to further understand the differences in the use of gestures in younger and older children included in the study, independent sample t-tests were run. The first analysis compared the use of all gestures produced by these children (group X mean= 46.14, SD= ±54.86; group Y mean= 33.63, SD= ±41.85). The results revealed that there were no significant differences (t=.396; p=.591) between the two groups, which could suggest that children in both age groups produced gestures at a comparable rate during the story retelling task. The second analysis compared the use of referential gestures and beats between younger and older children. The independent samples t-test revealed that there were no statistically significant differences seen in

the use of both types of gestures between the two groups (referential type/t=1.292; p=.215; beats/t=.310; p=.761). A third analysis was computed in order to understand the differences in the use of gestures types within each group. This analysis using paired samples t-tests revealed that there were no significant differences seen in the use of referential and beat gestures (see figure 1) produced by the children within each group (group X (t=19.756; p=.347); group Y (t=2.009; p=.072)).

**Figure 1**

*Mean and standard deviation of referential and non-referential (NR) gestures for both groups of children.*




Next, in order to understand the influence of quantity of spoken output on the use of gestures, the following tests were computed. An independent samples t-test was run and it was found that children in Group Y (mean=56.82, SD= ±30.69) were found to speak more, i.e., they

significantly produced a greater number of utterances in their narration (t=1.931; p=.042), than children in Group X (mean=32.43, SD= ±15.82). This difference can also be noted in the data outlined in Table 3. Older children produced more utterances (n= 625) when compared to their younger (n= 227) counterparts.

Subsequently, two Pearson's correlations were performed in order to determine whether referential and beat gestures co-varied with spoken output across children in both groups. Figures 2 and 3 represent the scatter plots of the number of utterances and number of beats and non-referential gestures produced by the two groups of children. Visually, the scatter plots suggest that these variables are positively correlated, however, this was not fully supported by the correlation analysis. For group X, there were no statistically significant positive correlations between the number of utterances and the number of referential gestures ($R = 0.188$, $p = 0.687$) as well as beats ($R = -0.191$, $p = 0.681$). However, for group Y, there was a statistically significant positive correlation between the number of utterances and the number of referential gestures ($R = 0.673$, $p = 0.023$), while the same was not seen for beats gestures (i.e., statistically insignificant positive correlation; $R = 0.490$, $p = 0.126$). These results suggest that older children who spoke more produced more referential gestures and not beat gestures.

**Figure 2**

*Number of gestures used as a function of the number of utterances produced by children in group X.*

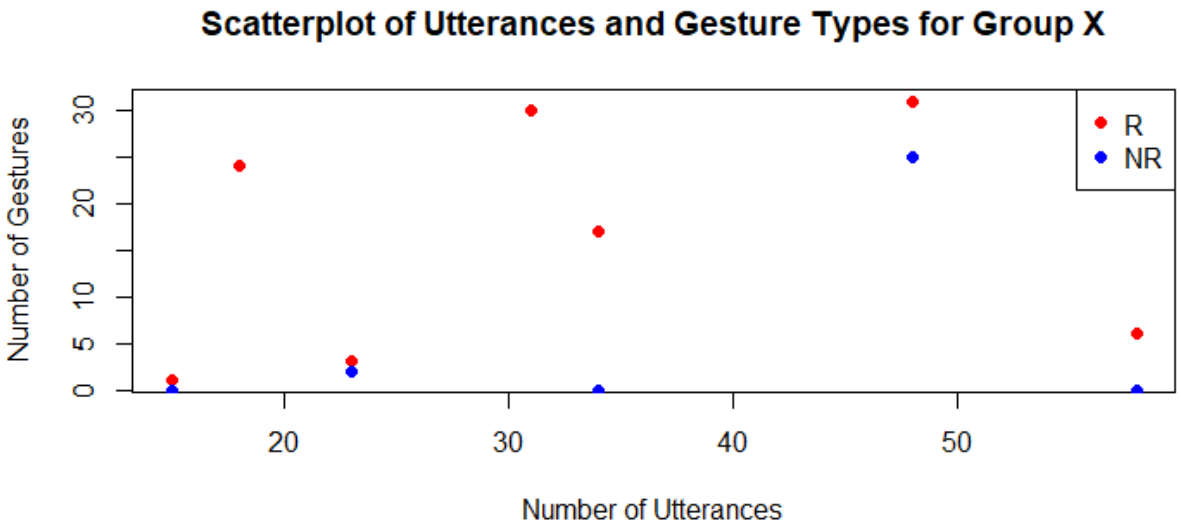
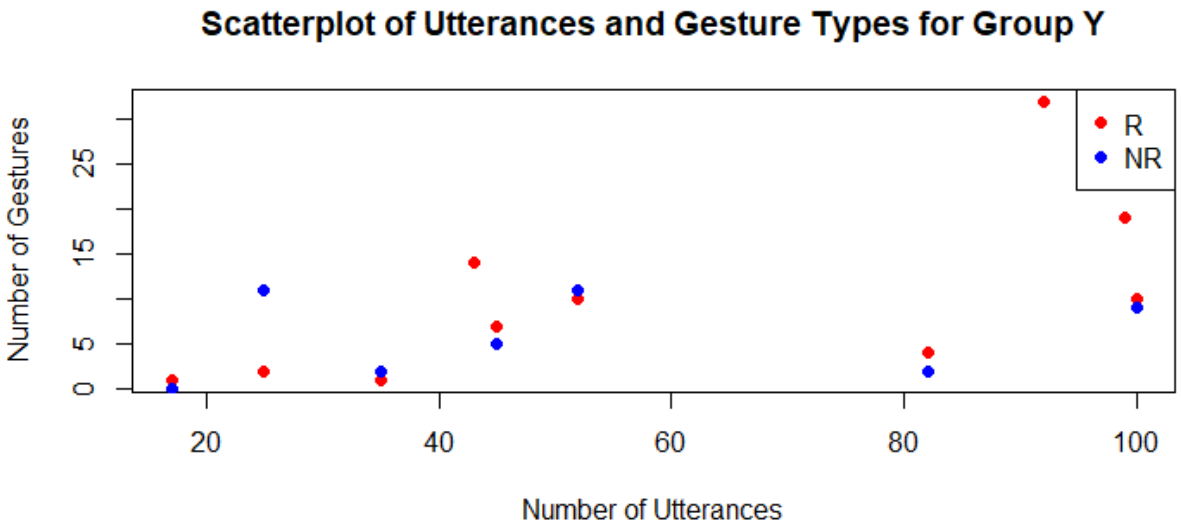



**Figure 3**

*Number of gestures used as a function of the number of utterances produced by children in Group Y.*



**Research question 2**: Will Canadian-English speaking children in the age range of 5-to-9 years use non-referential gestures more with content words (e.g., nouns, verbs) when compared to function words (e.g., determiners, connectives).

It was seen that children's gestures co-occurred more with words (62.02%) than with pauses (37.97%) during the discourse task. This suggests that children's gestures frequently accompanied spoken output during the discourse task. The distribution of both beats and referential gestures that co-occurred with content and functional words, across the two groups of children, are outlined in Tables 4 & 5. As can be seen from the tables, there is variation in the patterns of co-occurrence of gestures and word types across children in both groups. Younger children were observed to produce their referential gestures more with content than function words. The opposite trend was seen in older children; i.e., they produced beats with both types of word categories.

**Table 4.**

*Co-occurrence patterns of gesture types and word types for children in group X.*

| **Group** | **Content words** | | **Function words** | |
|---|---|---|---|---|
| **X** | **Referential gestures** | **Beat gestures** | **Referential gestures** | **Beat gestures** |
| **X2** | 11 | 0 | 4 | 0 |
| **X3** | 1 | 1 | 1 | 0 |
| **X5** | 12 | 8 | 4 | 5 |
| **X6** | 1 | 0 | 1 | 0 |
| **X8** | 0 | 0 | 0 | 0 |
| **X10** | 16 | 15 | 3 | 15 |
| **X11** | 15 | 10 | 10 | 5 |

**Table 5**

*Co-occurrence patterns of gesture types and word types for children in group Y.*

| **Group** | **Content words** | | **Function words** | |
|---|---|---|---|---|
| **Y** | **Referential gestures** | **Beat gestures** | **Referential gestures** | **Beat gestures** |
| **Y2** | 5 | 3 | 3 | 3 |
| **Y3** | 29 | 46 | 4 | 15 |
| **Y4** | 20 | 23 | 3 | 20 |
| **Y6** | 7 | 3 | 0 | 1 |
| **Y7** | 2 | 7 | 0 | 3 |
| **Y9** | 3 | 2 | 0 | 0 |
| **Y10** | 1 | 1 | 0 | 1 |
| **Y11** | 1 | 0 | 0 | 0 |
| **Y12** | 0 | 2 | 0 | 0 |
| **Y13** | 6 | 3 | 1 | 1 |
| **Y14** | 8 | 41 | 2 | 15 |

Further, in order to understand the influence of age on co-occurrence patterns, independent sample t-tests were run. The results revealed that there were significant differences in the co-occurrence of content words with beats (t=.229; p=.035; mean for group X= 4.86, SD= 6.12; mean for group Y= 11.91, SD= 16.89), between the two age groups, and the opposite trend was seen in the co-occurrence patterns of content words with referential gestures (t=.135; p=.894; mean for group X= 8.00, SD= ±7.07; mean for group Y= 7.45, SD= ±9.05). There were no significant differences found in the co-occurrence patterns of function words with both referential gestures (group X/t=1.824; p=.087; group Y/t=-.545; p=.593) and beats (group X/t=-1.052; p=.229; group Y/t=1.401; p=.295)

## Chapter 4: Discussion

This study aimed to document the developmental patterns of use of non-referential gestures, also known as beats, in Canadian- English speaking typically developing children between the ages of 5 and 9 years. This was done in the context of (1) comparing the use of beats with the use of referential gestures, as both these types of gestures are used by children; (2) evaluating the influence of age and spoken output on the use of beats and referential gestures, and (3) comparing the patterns of co-occurrence of beats and referential gestures with linguistic units, such as content and function words. Therefore, the following research questions and hypotheses were examined:

1. Will Canadian-English speaking children in the age range of 5-to-9 years use non-referential gestures with adult-like characteristics, i.e., gestures with well-defined stroke phases, and demonstrate the influence of age and spoken output in the of use of non-referential gestures?

   Here the assumption was that most children in the age range of 5-to-9 years would produce beat gestures that could be identified by their well-defined stroke phases. It was also assumed that children in the age range of 7.0 to 8.11 years would use more beat gestures, than children in the age range of 5.0 to 6.11 years, and that their beat gesture production would positively align with their utterance production.

2. Will Canadian-English speaking children in the age range of 5-to-9 years use non-referential gestures more with content words (e.g., nouns, verbs) when compared to function words (e.g., determiners, connectives).

   Here the assumption was that beat gestures would co-occur more with content words than with function words, similar to patterns established for referential gestures.

The results of this study revealed the following developmental trends for beats and referential gesture production in the Canadian-English speaking children who were between 5 and 9 years of age.

**Patterns of use of beat gestures**

It was found that all the children who participated in the study used gestures; however, there were some differences in the use of the two types of gestures. All children demonstrated the use referential gestures, but the same did not hold good for the use of beats. However, it was noted that these children produced beats with a greater frequency when compared to referential gestures. This pattern is different from findings reported in Mathew et al.'s (2018) study, where they found that 6-year-old Australian English-speaking children tended to use more referential gestures. However, there are differences in the number of participants and the linguistic backgrounds of the children considered in the two studies. The pattern in the current study, noticeably, is consistent with McNeill's (2005) proposal and the finding of previous studies in French (Nicoladis, et al., 1999) and Catalan speaking children (Vila & Prieto, 2020), in that these studies have suggested that beat gesture production increases with age, possibly as a direct result of maturation of linguistic skills such as narration.

Further, just like predicted, beats produced by the children in this study were characterized by a well-defined stroke phase, similar to that seen in adults (Kendon, 1980; Shattuck-Hufnagel et al., 2016). These finding suggests that most Canadian-English speaking children above the age of 5 years are producing beats, during discourse, with adult like gesture morphology. Surprisingly, children in this study were not found to use adult-like distribution of gestures. 69.26 % of their gestures were beats as opposed to 30.74% (McNeill, 1985) typically used by adults in conversation. This could perhaps be attributed to the nature of the discourse

task, since the children were engaged in a narrative task, which is a monologue, as opposed to a conversational task, which is a dialogue. Additionally, it is not surprising that some children did not use beats, and that there were 6 other children who did not produce a single gesture during the task. Such individual variability in the use of gestures has been previously reported in adults (Özer & Goksun, 2020) as well as in children (Goldin-Meadow, 2015).

***Beats as a function of age***

It was interesting to note that there were no effects of age noticed in this study, and this did not support the predictions made for this study. Recall that children in the study were divided into two groups; i.e., one group which consisted of younger children (5.0 – 6.11 years) and the other which consisted of older children (7.0 – 8.11 years). There were no statistically significant differences observed in the use of beats as well as referential gestures, both within and between the two groups. This is unlike the findings of previous studies, such as that of Colleta et al. (2010) and Nicoladis et al. (1999), which have documented a clear influence of age on the use of beats and referential gestures. The distribution of data, however, does demonstrate that a greater number of children in the older age group produced more beats when compared to referential gestures. While in the younger age group, only 4 children produced beats. This could suggest that referential gestures could lead language output in early childhood and this role is then taken over by beats in older children (Özçalışkan & Goldin-Meadow, 2005). However, this comparison should be interpreted with caution since there was unequal distribution of children studied in both groups.

***Beats as a function of age and spoken output***

It was found that older children spoke more while re-telling the story. The data distribution suggested that there were positive correlations between spoken output and both types

of gestures. However, contrary to predictions, the only significant correlation found was between utterances and referential gestures, and in the older group. This is unlike earlier reports which suggest that a strong correlation exists between gestures (beats and referential gestures) and spoken output (e.g., Nicoladis et al., 1999; Colletta et al., 2010; Mathew et al., 2018). It should be notes that individual variability was also observed. For example, there were children in both groups who spoke more but they produced a smaller number of gestures. The opposite trend was also seen, i.e., few children who spoke more also produced more gestures, irrespective of the gesture type.

It is possible that the nature of the task could have contributed to these findings in this study. It has been suggested that gestures help children organize information and eases their cognitive load during communication (Goldin-Meadow, 2000). However, a recent study in adults has suggested that gestures variably interact with different types of tasks and as a result the extent to which they benefit a speaker could vary (Overoye & Wilson, 2020). This may support the findings in the study. The children in this study were engaged in a story retelling task. They were unfamiliar with the story line of the movie clip and as a result the task could be considered as challenging when compared to a well-rehearsed and familiar story line. Therefore, the lack of familiarity could have taxed the participants' cognitive load, and could have influenced the way children produced gestures and utterances. It is also possible that the presence of an unfamiliar interlocutor could have also influences cognitive load, since the researcher was not known to the participants.

***Co-occurrence patterns of beats with linguistic units as a function of age***

Children's gestures co-occurred more with words than pauses. This is consistent with previous findings that gestures, both in adults and children, occur with spoken utterances as they

help organize linguistic information in a multimodal format during communication (Goldin-Meadow, 2000). Beats produced by older children tended to co-occur only with content words, and not with function words. This is consistent with the findings of Blake et al. (2008) and Mathew et al. (2018). A possible explanation for this observation could be that nouns and prepositional phrases are likely to be the loci of new information, and they subsequently mark emphasis (Blake et al., 2008). It has been documented that linguistic units that serve an emphatic function also tend to attract beats in discourse. This has been previously established in studies of beats as well as referential gestures in both adults and children (Loehr, 2012; Esteve-Gibert and Prieto, 2018). However, this explanation is not applicable to the trends observed for referential gestures (for both groups) and for younger children, in this study. This could be because most children in this study preferred to use beats than referential gestures. Alternatively, this could also suggest that our current understanding of the relationship between gestures and spoken output is still not well established. Therefore, it is possible that discursive functions of gestures could differ as a result of differences in linguistic encoding, but the relationship is not straightforward since children are still developing their multimodal discourse skills.

**Limitations**

There are several limitations to this study. Firstly, this study included a relatively small sample size of participants. The study included two age groups, however there was unequal distribution of participants between these groups. This could have influenced the statistical analyses and can affect the generalizability of the results. Secondly, there were limitations when recruiting participants. The researcher had to rely on approvals from school districts in order to recruit participants. Recruitment process was also influenced by the inability of the researcher to personally interact and describe the study to caregivers of potential participants. All communication was done via email and through classroom teachers, and this was based on the

directives and COVID-19 guidelines set by the school approval board. Thirdly, data collection was from a school district which primarily enrolls students from diverse cultural and linguistic backgrounds. This meant that most children were either bilingual or multilingual Canadian-English speakers. This fact combined with the small sample size did not allow for better control over cultural and linguistic parameters which can influence both discourse and gesture production. Lastly, it is possible that the lack of familiarity with the storyline and the presence of an unfamiliar interlocuter could have influenced both gesture production and spoken output in the children included in the study. Although the present study followed a similar methodology as that of other studies, discourse tasks and interlocuters can certainly influence the cognitive load needed for multimodal communication.

**Future directions**

Future research is needed to capture and expand on the limitations of the current study. Therefore, it is important that future studies include a larger sample size for a better understanding of the influence of age on multimodal communication. Also, studies with larger sample sizes and including a wider age range of children can help us better understand the influence of variables such as age, different discourse tasks, different interlocutors, as well as cultural and linguistic influences. It is also important to note that developmental trends for gesture and spoken output documented in this study was for typically developing children. Future research is needed to document these trends in children with language impairments, in order to better understand the relationship between gestures, particularly beats, and language production in these children.

## Conclusion

The present study found that typically developing Canadian-English speaking children between the ages of 5 and 9 use both non-referential and referential gestures, when engaged in a story re-telling task. The children were observed to use beat gestures with adult-like characteristics, and with more frequency than referential gestures. Additionally, it was shown that younger children used referential gestures more frequently with content than function words, while older children used beats with both function and content words. The developmental trends noted in the use of gestures, when considered in the context of variables such as age, the quantity of spoken output, as well as the alignment with linguistic units, were not substantiated by the statistical analyses. However, these findings could also suggest that children in the age range of 5-to-9 years have not yet formed a clear link between the use of beats and referential gestures with spoken output. These findings clearly suggest multiple avenues for future research that can document the use of beats as a function of communicative competence in a wider age range of children using a variety of discourse tasks, interlocuters, and culturally and linguistically diverse neurotypical and neurodivergent populations.

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# Appendix A

## Recruitment Flyer

## Appendix B

## Demographic Questionnaire

This study is aimed to determine multimodal discourse functions in children aged 5-9. Before data collection occurs, I would like to start by asking you some background information about your child and family in order to compare results across other studies. Please try to be as forthcoming as possible when answering these questions, but be assured that the answers you give will be kept confidential.

1. BACKGROUND DETAILS

   Child's date of birth: _____

   Child's Sex: ☐ Female ☐ Male

2. HOUSEHOLD INFORMATION

   Primary language spoken in the home: ☐ English ☐ French ☐ Spanish ☐ Other

   All languages spoken: _____

   Race/Ethnicity: _____

   Number of family members living in child's home: _____

   Number of years in school: _____

3. MEDICAL HISTORY

   Does your child have a history of hearing impairment: ☐ Yes ☐ No

   If yes, does your child use an amplification system: ☐ Yes ☐ No

   Does your family have a history of hearing loss: ☐ Yes ☐ No

4. VISUAL SKILLS

   Does your child have a history of visual impairment: ☐ Yes ☐ No
   If yes, does this impairment affect your child's visual abilities:
   _____

## Appendix C

### Development of language and nonverbal behaviors in children

### Parental/Guardian Consent Form

Your child is invited to participate in a research study about the development of storytelling abilities and nonverbal behaviors in children aged 5-9.

If you agree to be part of the research study, your child will be asked to complete two tasks based on a short cartoon video clip. The tasks will be a story re-telling task and an explanation task. During the tasks video and audio will be recorded to collect information. These tasks will take around 10-15 minutes to complete, and your child will be pulled from class-time in order to complete them. Data will be collected in the school premises.

Benefits of the research include understanding the development of language and nonverbal abilities in children.

There are no risks or discomforts known to be associated with this study.

Data collected will remain confidential. The researcher will only use aggregate/group data while reporting the results of the study. Short video clips or pictures may be used while reporting the study to committees or at conferences, only after ensuring that all facial identity markers are erased.

Participating in this study is completely voluntary. You and/or your child can withdraw at any time without any penalty. The decision whether or not to participate will not affect your or your child's current or future relations with the school division, St. Cloud State University, or the researcher.

If you or your child have questions about this research study, please contact Allison Cruse at amcruse@go.stcloudstate.edu or Dr. Mili Mathew at mmathew@stcloudstate.edu. Results of the study can be requested from the researcher.

Your signature indicates that you and your child have read the information provided here and have decided to participate. You or your child may withdraw from the study at any time without penalty after signing this form.

| | |
|---|---|
| Student Name (Printed) | Parent(s')/Guardian(s') Name (Printed) |
| Parent(s')/Guardian(s') Signature | Date |

## Appendix D

## Development of language and nonverbal behaviors in children

## Child Assent Protocol

I want to learn how children tell stories and answer questions. Your (mom/dad/caregiver) is okay with you taking part in my study. I will ask you to see a video clip. After that I will ask you to tell me the story you saw and I will also ask you five questions about the story. I will record you while you do these. If you feel uncomfortable or upset at any time you can let me know and we will stop.

Are you interested in seeing the video and telling me the story? Yes/No

# Appendix E

## IRB Approval

ST. CLOUD STATE UNIVERSITY
EDUCATION FOR LIFE.

**Institutional Review Board (IRB)**
720 4th Avenue South AS 210, St. Cloud, MN 56301-4498

**Name:** Allison Cruse

**Email:** amcruse@go.stcloudstate.edu

**IRB PROTOCOL DETERMINATION:**
**Expedited Review-1**

**Project Title** Use of Non-Referential Gestures in Typically Developing Canadian- English speaking Children

The Institutional Review Board has reviewed your protocol to conduct research involving human subjects. Your project has been: **APPROVED**

Please note the following important information concerning IRB projects:

- The principal investigator assumes the responsibilities for the protection of participants in this project. Any adverse events must be reported to the IRB as soon as possible (ex. research related injuries, harmful outcomes, significant withdrawal of subject population, etc.).

- For expedited or full board review, the principal investigator must submit a Continuing Review/Final Report form in advance of the expiration date indicated on this letter to report conclusion of the research or request an extension.

-Exempt review only requires the submission of a Continuing Review/Final Report form in advance of the expiration date indicated in this letter if an extension of time is needed.

- Approved consent forms display the official IRB stamp which documents approval and expiration dates. If a renewal is requested and approved, new consent forms will be officially stamped and reflect the new approval and expiration dates.

- The principal investigator must seek approval for any changes to the study (ex. research design, consent process,

If we can be of further assistance, feel free to contact the IRB at 320-308-4932 or email ResearchNow@stcloudstate.edu and please reference the SCSU IRB number when corresponding.

**IRB Chair:**

Dr. Mili Mathew
Chair and Graduate Director
Assistant Professor
Communication Sciences and Disorders

**IRB Institutional Official:**

María-Claudia Tomany

Dr. Claudia Tomany
Associate Provost for Research
Dean of Graduate Studies

**OFFICE USE ONLY**

| | | |
|---|---|---|
| **SCSU IRB#:** 2072 - 2701 | **Type:** Expedited Review-1 | **Today's Date:** 3/2/2022 |
| **1st Year Approval Date:** 2/28/2022 | **2nd Year Approval Date:** | **3rd Year Approval Date:** |
| **1st Year Expiration Date:** 2/27/2023 | **2nd Year Expiration Date:** | **3rd Year Expiration Date:** |

# Appendix F

## IRB Approval 2

INSTITUTIONAL REVIEW BOARD (IRB)
720 4th Avenue South AS 101, St. Cloud, MN 56301-4498

Date: April 7, 2023

Name: Allison Cruse
Email: amcruse@go.stcloudstate.edu

Faculty Mentor/Advisor: Joy McKenzie

**IRB PROTOCOL DETERMINATION:**
Expedited

The Institutional Review Board has reviewed your continuing review for your protocol to conduct research involving human subjects.

PROJECT TITLE: **Use of Non-Referential Gestures in Typically Developing Canadian- English speaking Children**

Your project has been: **Approved**

SCSU IRB#: **20722701**

**1st Year Approval Date:** February 28, 2022 **1st Year Expiration Date:** February 27, 2023
**2nd Year Approval Date:** February 27, 2023 **2nd Year Expiration Date:** February 26, 2024
**3rd Year Approval Date:** **3rd Year Expiration Date:**

Please read through the following important information concerning IRB projects.

- The principal investigator assumes the responsibilities for the protection of participants in this project. Any adverse events must be reported to the IRB as soon as possible (ex. research related injuries, harmful outcomes, significant withdrawal of subject population, etc.).
- The principal investigator must seek approval for any changes to the study (ex. research design, consent process, survey/interview instruments, funding source, etc) by completing an IRB Modification/Revision Request Form.
- The IRB reserves the right to review the research at any time.
- Expedited and full board review projects are up for annual renewal (1 year from your approval date, or on the expiration date listed on the approval stamp) and the principal investigator is *required* to report the status of the project *prior to the expiration date* by completing one of the following:
  - Continuing Review Form: Request to extend the project as either subject recruitment/enrollment continues or data collection continues and the project has not concluded.
  - Final Report Form: Indicate project completion as data collection is complete (data anaylsis may continue).
    - *You will receive an email reminder approximately one month in advance of the expiration date. NOTE: if a report form is not submitted timely, the protocol will be closed and a new submission will be required.*
- Approved consent form(s) and recruitment document(s) display the formal SCSU IRB stamp which is indication of official approval and lists expiration dates. These are the forms to be used during the project study. *If a renewal is requested and approved, new consent forms will be officially stamped and reflect the new approval and expiration dates.*

Feel free to contact the IRB for assistance at 320-308-4932 or email ResearchNow@stcloudstate.edu and reference the SCSU IRB number when corresponding for expedited response. Additional information can also be found on the IRB website https://www.stcloudstate.edu/irb/protocol.aspx.

Sincerely,
**IRB Chair:**
William Collis-Prather
Program Director
Applied Clinical Research

**IRB Institutional Official:**
Dr. Claudia Tomany
Associate Provost for Research
Dean of Graduate Studies