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Coordinated interpersonal timing in the conversations of children who stutter and their mothers and fathers

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Abstract

Coordinated interpersonal timing (CIT) is a measure of "conversational congruence," or "attunement," and refers to the degree to which the temporal aspects of the vocal behaviors of co-conversationalists are correlated over the course of a conversation [Jasnow, M., & Feldstein, S. (1986). Adult-like temporal characteristics of mother–infant vocal interaction. *Child Development*, *57*, 754–761]. In the present study, CIT was examined in a group of children who stutter (CWS), and a matched group of nonstuttering children (CWDNS; children who do not stutter), during conversations with either their mother or father recorded in two separate sessions (i.e., mother–child, father–child). Separate audio signals for both the child and parent (mother or father) were analyzed using AVTA software, which allowed for the quantification of sound and silence patterns in simultaneous speech. Squared cross-correlations (i.e., coefficients of CIT) for the durations of five vocal behavior states were obtained for each subject, through time series regression analysis using lag procedures. Vocal state behaviors within conversational turns included: vocalization, pauses, turnswitching pauses, and interruptive and noninterruptive simultaneous speech. Results indicated that CWS and their parents showed mutual influence (i.e., CIT in both directions,

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child to parent and parent to child, or bi-directional influence) for more vocal state behaviors than did CWDNS and their parents. In addition, the CWS exhibited CIT with their parents for the durations of more vocal state behaviors than did the CWDNS (i.e., unidirectional influence). Findings suggest that children who stutter may be more easily influenced by the subtle timing aspects of conversation. Taken further, some of these children may perceive conversations with their parents as either challenging or difficult because of an element of unpredictability brought into conversations by the production of stuttering, the social skills of the child, and the nature of the parent–child relationship. Consequently, these children may be engaging in more pervasive coordination of the temporal characteristics of their speech to those of their conversational partner, as a mechanism by which to more effectively manage verbal interaction.

Educational objectives: After reading this paper, the learner will be able to: (1) describe the phenomenon of coordinated interpersonal timing (CIT); (2) summarize research findings in CIT as they apply to the verbal interactions of children and their parents; (3) summarize research findings in parent–stuttering child interaction, especially those related to the temporal aspects of both parent and child conversational speech, and (4) discuss the applicability of the findings from the present study to the treatment of childhood stuttering.

Keywords: Coordinated interpersonal timing; CIT; Children who stutter; Mothers; Fathers

1. Introduction

Contemporary theories of stuttering take into account the potential role that the verbal environment of the child plays in its development (e.g., Adams, 1990; Smith & Kelly, 1997; Starkweather & Gottwald, 1990). Specifically, over the years numerous investigators have attempted to uncover the verbal and nonverbal behaviors of parents that may represent risk factors for either the occurrence of stuttered speech, or the development of a persistent stuttering problem. Early studies focused broadly on both the content and form of the language parents use while engaged in conversation with their child and, more narrowly, on the specific responses of parents to their child's stuttering (e.g., Glasner & Rosenthal, 1957; Johnson & Associates, 1959; Kaprisin-Burelli, Egolf, & Shames, 1972; Langlois, Hanrahan, & Inouye, 1986; Weiss & Zebrowski, 1991, 1992). In general, findings from these studies indicate that the parents of some children who stutter are inclined to respond negatively to the child's stuttering, or to advise the child about how to talk (e.g., "slow down," "take a deep breath"). The significance of this early work is that it provided researchers and clinicians with the first glimpse into the relationship between stuttering and the child's and parent's language, implicating such factors as communicative demand and language complexity.

The notion of communicative demand in the form of "time pressure" was an outgrowth of these early studies of parent–child verbal interaction, and has received a significant attention in the clinical literature. Time pressure has been broadly defined as the perception of being rushed to talk during conversation. Such perception on the part of a child has been speculated to arise from the parents' use of such temporal speech behaviors as a rapid speaking rate, short turn-switching pauses, and a tendency to frequently interrupt the child or talk simultaneously when talking with him or her. A number of researchers and clinicians have proposed that a child who stutters who is chronically exposed to such a rapid parental speech tempo develops strategies to "keep up" with the conversation, and that such strategies include increases in speech rate, decreases in turn-switching pause duration, or both. Over time, this habitual approach to communication as the child's language is becoming more adult-like interacts with other risk factors (e.g., a speech motor system vulnerable to disruption), resulting in the exacerbation of speech disfluency and stuttering (e.g., Adams, 1990; Andrews et al., 1983; Bloodstein, 1975, 1995; Conture, 1990; Kent, 1981; Starkweather, 1997; Starkweather & Gottwald, 1990; Yairi & Ambrose, 2005). The notion that an accelerated speaking rate leads to increased frequency in fluency disruptions has also received indirect support from the well-documented observation that therapy that incorporates rate reduction consistently leads to increased (albeit controlled) fluency for people who stutter (e.g., Andrews, Neilson, & Cassar, 1987). If it can be assumed that rate reduction leads to fluency (at least in the short term), and communicative time pressure can lead to increased rate and therefore a higher likelihood of stuttering, then a link between rate and fluency can also be assumed.

Researchers began to investigate the validity of communicative time pressure and its potential relationship to stuttering in children by focusing on the temporal aspects of the conversations between young children who stutter and their parents. The main goal of these studies was to examine timing behaviors that occur during parent–stuttering child interactions, and compare observations from these dyads to those observed in conversations between young nonstuttering children and their parents (e.g., Craig & Gallagher, 1983; Garvey & Berninger, 1981). The timing behaviors of interest included: speaking rates of children and parents (Kelly & Conture, 1992; Meyers and Freeman, 1985b), number of parent interruptions (e.g., Egolf, Shames, Johnson, & Kasprisin-Burrelli, 1972; Kasprisin-Burrelli et al., 1972; Kelly & Conture, 1992; Meyers and Freeman, 1985a; Mordecai, 1979), the duration of simultaneous talking, or "simultalk" (Kelly & Conture, 1992), and the durations of switching pauses in parent–stuttering child conversation (e.g., Kelly & Conture, 1992; Logan & Conture, 1997; Yaruss & Conture, 1992).

Overall, findings from these studies yielded equivocal results, but in general supported the notion that the temporal aspects of parent-stuttering-child conversations do not differ significantly from those observed in parent-nonstuttering child conversations (Zebrowski, 1991). There are a number of obvious factors that likely contributed to inconsistent findings, including differences in subject age and stuttering severity, measurement procedures and other sources of within and between-group variability. In response to the results of these and related investigations, Kelly (1994), and Meyers and Freeman (1985b) argued that any parent's or child's temporal behavior during conversation – whether it be speaking rate, number and duration of interruptions or switching-pauses – is not as clinically relevant as the *relative* difference between the vocal behavior of the child and parent as they talk with each other. Kelly (1993, 1994) described this relative difference between parent and child speaking rate as "dyadic" rate, and noted that in some parent–child dyads there appears to be what might be considered a clinically significant 'mismatch' between the parent and child in terms of speaking rate, and that similar differences might also be seen in switching pause durations and rate and duration of interruptions. For example, Meyers and Freeman (1985b) reported that the stuttering children in their study and their mothers exhibited a dyadic rate of 2.09 syllables/s, whereas the nonstuttering child–mother pairs differed in speaking rate by 0.77 syllables/s. Kelly and Conture (1992) on the other hand, observed the opposite trend; that is the dyadic or 'difference' rate for their stuttering child–mother pairs was smaller than that of the nonstuttering child–mother pairs in their study (0.84 and 1.70 syllables/s, respectively). Finally, Kelly (1994) reported that in stuttering child–father dyads, there tended to be a larger dyadic rate than in stuttering child–mother pairs, and a significant and positive correlation between the severity of the child's stuttering and the dyadic rate. That is, the larger the difference between father and child speaking rates, the more severe the child's stuttering tended to be.

With the recognition of individual differences in so-called turn-management timing behaviors, in the late 1980s research in the temporal aspects of parent–stuttering child interaction shifted to investigations of the effects of parental manipulation of speech rate and turn-switching pause duration on the speech and speech fluency of children who stutter. That is, given that the parent of a child who stutters does not exhibit a faster than normal speaking rate or shorter turn-switching or inter-turn durations in conversation, is there evidence that slowing rate and increasing the durations of the silences between conversational turns will lead to decreases in the child's disfluent speech? This became an important research focus which continues to the present day, and is especially relevant given the large number of published therapy approaches for young children who stutter that call for the use of a slowed parental speaking rate (e.g., Conture, 2001; Guitar, 2006; Gregory, 2003; Starkweather, 1997; Zebrowski & Kelly, 2002).

As a way to assess the validity of this practice, several investigators examined the effects of training parents to slow their speech rate, increase the duration of their switching pauses, and use shorter, simpler utterances when talking with their children who stutter (e.g., Guitar & Marchinkoski, 2001; Bernstein Ratner, 1992; Stephenson-Opsal & Bernstein Ratner, 1988; Zebrowski, Weiss, Savelkoul, & Hammer, 1996). The most consistent finding in this work was that for the most part, parents can reduce their speaking rate following instruction, and for some children who stutter, a slowed parent speech rate leads to decreased stuttering, even if the child does not slow his or her speaking rate. Perhaps the most salient finding from this work is that the relationship that exists between the speech of parents, and the speech and fluency of children who stutter, is highly individualistic.

This line of research has provided some insight into what parents do when talking with their child who stutters, and to a very limited extent, what effect their speech and language might have on the child's speech, language, and stuttering. While providing an important foundation, previous work in the temporal aspects of conversations between children who stutter and their parents has not addressed the central question which is this: do the temporal behaviors that characterize parent–child interaction *influence* the child's speech within conversation, and if so, is there a secondary effect on the child's speech fluency? The first step in addressing this issue is to go beyond the separate measurement and comparison of the temporal speech behaviors of parents and their children who stutter in conversation, and instead examine the extent to which the speech behavior of these parents of children influences similar or related speech behaviors in the child. The next step would be to examine the consequences of any influence that might be observed on the frequency or nature of the child's speech fluency and stuttering. Analysis of means of temporal measures across an entire conversation may or may not yield differences between co-conversationalists, but if they do, such differences may not *make* a difference if they are not related to fluency in some fashion. In fact, although there is much clinical literature promoting reduced parent or clinician speech rate for the treatment of early stuttering, there continues to be a debate about the evidence for such a recommendation (e.g., Ingham, 2004).

Temporal influence in conversation can be either reciprocal or compensatory (Cappella, 1981). If influence is reciprocal, changes in behavior produced by one person are followed by changes in the same direction by another. For example, within dyads increases in turn-switching pauses for one speaker are followed by, or matched, by increases in the same or related behaviors by the second. For reciprocity to be present, matching responses need to be observed for both increases and decreases of the behavior of interest (e.g., pause duration). In compensatory influence, the opposite would be true: decreases are followed by increases, and increases followed by decreases.

It is apparent that reciprocal, or mutual, influence is the most salient when considering the frequent speculation that reductions in parents' speech rate, or increases in their turn-switching pauses while talking with their child who stutters, will be mirrored by the child and lead to increased fluency. The second part of this hypothesis is beyond the scope of the present study;

that is, before any relationship between parents' speech and the child's stuttering behavior can be addressed, we first need to see whether or not the phenomenon of reciprocal, or mutual, influence in parent–stuttering child dyads is evident. To understand the nature and potential role of reciprocal influence in parent–stuttering child conversation, it is necessary to examine the simultaneous speech of both the parent and the child as they talk with one another, and assess the extent to which the temporal aspects of their vocal behaviors are correlated over the course of the interaction. This is the main purpose of the present study.

1.1. Measurements of reciprocal influence in conversation

A well-established method for analyzing the phenomenon of reciprocal influence in the temporal aspects of dialogue is through the measurement of coordinated interpersonal timing (Welkowitz, Cariffe, & Feldstein, 1976). Coordinated interpersonal timing, or CIT, reflects a systems view of communication, in which the dyad is considered the basic unit within which each member of a conversation is considered solely as he or she functions within the context of the dyad. As such, all vocal behavior (sounds and silences) of the two speakers is subject to the possible simultaneous, mutual influence exerted by them. CIT, then, is a measure of "conversational congruence" or "attunement," and refers to the degree to which the temporal aspects of the vocal behaviors of co-conversationalists are correlated over the course of a conversation (Jasnow & Feldstein, 1986; Welkowitz et al., 1976). The measurement of CIT involves a process whereby each speaker's vocal behaviors are first parsed into speaking turns (the superordinate parameter), with five vocal states within each turn. These vocal states are: *vocalization, pauses, switching pauses, noninterruptive simultaneous speech,* and *interruptive simultaneous speech*. Both current and lagged correlations between the vocal states of the two speakers have been defined as "interpersonal contingency" or regulation. In the case of lagged correlations, or lagged CIT, each partner's vocal timing, or state, can predict the other's in conversation (Jaffe, Beebe, Feldstein, Crown, & Jasnow, 2001). For example, numerous studies of adult–adult and adult-child interaction have shown that participants of a dyad tend to "match," among other things, their speech rates, (Webb, 1972), expressive behavior (Cappella & Greene, 1982), and accent (Giles, Taylor, & Bourhis, 1973), as well as gestural behavior (LaFrance, 1979).

Studies of CIT have found that it is evident in interactions even in the earliest stages of development (e.g., mothers and infants; Jaffe et al., 2001). For example, children as young as four months achieve CIT of switching pause durations with their mothers (Beebe, Jaffe, Feldstein, Mays & Alson, 1985; Jaffe et al., 2001). In addition, preschoolers and their parents have been found to influence the durations of one another's turns, vocalizations, and switching pauses (Welkowitz, Bond, Feldman, & Tota, 1990). To date, only two published studies have examined coordinated interpersonal timing in the parent–child conversations of children with cognitive or communication disorders. In a study of the interaction between mothers and their 4- and 9-month-old infants diagnosed with Down syndrome, CIT for the durations of turns, vocalizations pauses, and switching pauses was evident for the children (after an initial delay) and their parents, suggesting that the ability to engage in congruence is not hampered by a child's cognitive delay (Jasnow et al., 1988). On the other hand, a second study involving adolescents diagnosed with autism revealed that these children did not achieve CIT with either their parents or the examiner; specifically, they did not coordinate the durations of their pauses or switching pauses with those of their conversational partner (Feldstein, Konstantareas, Oxman, & Webster, 1982).

While individuals and different types of dyads generate relatively stable and characteristic temporal speech patterns, it has been shown that these patterns appear to be sensitive to a host of psychological, situational and perhaps even biological conditions (e.g., Warner & Mooney, 1988; Welkowitz et al., 1990). This is not surprising given that the phenomenon of CIT itself is interpreted to be an example of empathic behavior in that it reflect the familiarity with, and responsiveness of each conversationalist to the speech rhythms of the other (Welkowitz & Kuc, 1973). That is, the presence of CIT suggests that conversational participants are aware of the characteristics (e.g., pause and vocalization durations) of each other's vocal timing (although not on a conscious level), and such awareness is implied by the presence of CIT.

The meaning of CIT is thought to depend entirely on the context in which it is measured. In particular, certain personality characteristics of the participants as well as their perceptions of uncertainty, challenge or threat within the dyad have been shown to be related to the amount of either bi-or unidirectional CIT generated within an interaction (Jaffe et al., 2001). For example, several studies have indicated that personality attributes such as social skill level, warmth and expressiveness can influence the attainment of CIT (Welkowitz & Kuc, 1973; Welkowitz, Cariffe, & Feldstein, 1976; Welkowitz et al., 1990). In addition, heightened sensitivity to both internal and external stimuli across sensory and temporal domains, and perceptions of unpredictability within the dyad, are two psychological factors that have been speculated to relate to CIT (Hane, Feldstein & Dernetz, 2003). The perception of unpredictability in interaction may stem from a number of sources, including level of familiarity and positive regard. For example, Crown (1991) found that "unacquainted" pairs of individuals engage in the greatest degree of mutual accommodation, followed by dyads consisting of individuals who "dislike" one another, and individuals who "like" one another. That is, it appears that co-conversationalists who are the least acquainted and/or the least comfortable with one another, are more likely to show greater amounts of coordinated interpersonal timing of their vocal behaviors in conversation. Feldstein (1998) suggested that "high" degrees of attunement between parents and their children may indicate the presence of problems in the interaction, and further speculated that children may attempt to manage unpredictability by engaging in coordinated interpersonal timing with their mothers as a regulatory mechanism.

The standard measure of coordinated interpersonal timing is the CIT coefficient, which is a squared semi-partial correlation coefficient obtained by means of a time-series regression analysis. CIT is considered to have occurred when the duration of one speaker's conversational turns, vocalizations, switching pauses, and simultaneous speech are predictable from those of a conversational partner, and vice versa. As such, separate coefficients are generated for each member of a dyad across the speech parameters of interest, allowing for examination of the presence and degree of his or her coordinated interpersonal timing. This allows for the assessment of both bi- and unidirectional influence; for example, a child may engage in coordinated interpersonal timing with a parent for one temporal parameter (e.g., switching-pause duration) within their conversation, but the parent might not reciprocate CIT with the child for the same parameter. In such a case, it would be concluded that the child is more easily influenced by the timing of the parent's turns than the other way around.

As previously discussed, the research and clinical literature concerned with stuttering contains numerous references to the role that parental speech plays in both the persistence of, and recovery from, childhood stuttering, as well as in intervention approaches that focus on manipulation of the child's verbal environment. Existing research in parent–stuttering child interaction has involved the analysis of means of specific measures (e.g., pause duration, speech rate) taken across an entire conversational sample. While these data have answered some basic questions (e.g., Do the parents of children who stutter speak faster than the parents of nonstuttering children?), they have not addressed the central issue, which is whether the temporal aspects of parental verbal interaction influence those same behaviors in the child's speech during parent–child conversations, and whether the child exerts similar influence on the parent. In addition, if coordinated interpersonal timing is achieved, is the effect unidirectional (e.g., parent influences child but not vice versa) or bi-directional (mutual influence)? This second question is particularly relevant to stuttering treatment for children, as a key premise of therapy approaches that advocate a slowed parental speaking rate is that when parents reduce their rate, their child will respond in kind.

The first step in addressing these and related issues is to know whether children who stutter and their parents exhibit the phenomenon of coordinated interpersonal timing (CIT) when they talk with each other, as has been described in the literature for child–parent dyads of various compositions. Thus, the purpose of this study was three-fold. First, we wanted to apply a well-established method (i.e., AVTA) of analyzing reciprocal influence in conversation to examine whether it exists in the verbal interactions of children who stutter and their parents, and if so, what is the nature of this influence? Specifically, is attunement or CIT for five vocal state and turn durations bi-directional, unidirectional, or absent in parent–stuttering child dyads, and how do these patterns compare to those seen in a similar group of nonstuttering children–parent pairs? Second, since prior work has suggested differences in vocal state durations (e.g., simultaneous talking), as well as CIT, we wanted to assess these phenomena in mother–child and father–child interactions, across the groups of stuttering and nonstuttering children. Finally, since the literature suggests that specific attributes of dyad members can influence CIT, we wanted to examine potential relationships that may exist between specific personality factors that characterize parent–stuttering child dyads and the presence and degree of coordinated interpersonal timing. The long-term goal of this preliminary work is to obtain a better understanding of how the production of stuttering may influence the temporal reciprocity that characterizes verbal interaction, and whether parent or clinician manipulation of such temporal parameters as pause duration and frequency and duration of simultaneous speech (among others) influences stuttering behavior as conversations with children who stutter unfold over time.

2. Method

2.1. Subjects

Subjects for this study consisted of 10 young children who stutter (CWS), an age (i.e., within three months) and gender-matched group of 10 children who do not stutter (CWDNS) served as the controls. The mean age of the children in each group was 5:10 (years:months), with a range from 4:4 to 9:0 years of age (see Table 1). As Table 1 shows, one stuttering and one nonstuttering child in the study were 8:9 and 9:0 years, respectively, and these children represented outliers to some extent. The other 18 children in the study ranged in age from four to six years of age. Subject recruitment was relatively difficult due to the rural geographic location (North Dakota and Canada). For this reason, and because prior research has shown that the phenomenon of interest in this study – coordinated interpersonal timing – has been observed across a wide range of ages, we chose to include these two older children to increase our sample size.

Each child was joined in the study by his/her biological mother and father, with the exception of two cases in which a father figure, not the child's biological father, was included. In these cases, the father figure was a male with whom the child was well acquainted, and with whom the child interacted on a daily or weekly basis. The parents of the stuttering and nonstuttering children

Table 1
Description of speech disfluency and related characteristics of children who stutter (CWS)

Subject (years:months)	Age (years:months)	Age of stuttering onset (years:months)	Mean frequency of speech disfluency in 100 words (%)	Predominant disfluency type
S1	6:4	2	13.5	Sound prolongations
S2	5:6	3:6	7.6	Sound prolongations
S3	4:7	3:6	3.5	Repetitions
S4	6:0	3:0	9.1	Sound/syllable repetitions
S5	6:1	4:4	4.1	Sound/syllable repetitions
S6	8:9	3	6.2	Sound/syllable repetitions
S7	6:0	5	7.7	Sound/syllable repetitions
S8	6:5	4	3.3	Sound/syllable repetitions
S9	4:3	2:6	5.9	Sound/syllable repetitions
S10	4:6	3:8	5.7	Sound prolongations

were matched for (a) level of education (within two years), (b) socioeconomic status, and (c) geographical location of residence. Children and their parents were referred for participation by speech-language pathologists from three neighboring cities: Minot and Bismarck-Mandan, North Dakota, and Regina, Saskatchewan, Canada.

2.1.1. Speech, language and fluency assessment

To be included in the study, all children had to exhibit speech, language, and cognitive skills that were within age-level expectations (except for stuttering for the CWS), and normal hearing acuity. Speech, language and cognitive status was assessed through administration of the Preschool Language Scale-3 (PLS-3) (Zimmerman, Steiner, & Pond, 1992) for children between the ages of four and six, and the Speech-Ease Screening Inventory (Pigott et al., 1985) for children between the ages of six and nine. The Columbia Mental Maturity Scale-Revised (CMMS) (Burgemeister, Blum, & Lorge, 1972) was administered to all children. Further, each child's hearing was screened binaurally at 20 dB SPL at 500, 1000, 2000 and 4000 Hz.

To be considered "stuttering," a child had to exhibit an average of three or more within-word or stuttering—like disfluencies (SLD; e.g., sound-syllable repetitions, sound prolongations) and/or monosyllabic whole-word repetitions per 100 words of conversational speech, and the parents expressed opinion that the child was either stuttering or a stutterer (Anderson, Conture, Pellowski & Kelly, 2003; Bloodstein, 1995; Conture, 2001; Zebrowski & Kelly, 2002). To assess frequency and type of speech disfluency for each child, one contiguous 300-word sample from the first 10-minutes of the videotaped mother–child conversation was analyzed. Table 1 shows the mean frequency of speech disfluency in 100 words and the predominant disfluency type observed for the children in the stuttering group.

2.1.2. Child and parent personality assessment

A second purpose of the present study was to conduct a preliminary examination of the role that parent, child and parent–child relationship attributes may play in the presence or extent of CIT in stuttering child–parent conversations. To this end, we chose to administer tests that assess the specific personality and relationship characteristics that have been implicated as salient to the presence and extent of CIT within parent–child dyads. First, we administered the personality inventory for children (PIC; Wirt, Lachar, Klinedinst, Seat, & Broen, 1984) to the stuttering and nonstuttering children in the study. The PIC is an objective, multidimensional measure of a child's behavior and emotional and cognitive status along a number of dimensions including social withdrawal, social skills and family relations, among others. Norms for the PIC were obtained from a sample of 2306 children between the ages of 4 and 18, and representative of different racial, ethnic and socioeconomic groups. Further, test-retest reliability (ranging from 0.82 to 0.92) and internal consistency (ranging from 0.81 to 0.92) are relatively high.

Mothers and fathers were administered two separate tests of personality, the 16 Personality Factor Questionnaire (16PF; Cattell, Cattell, & Cattell, 1993), and the personality attributes questionnaire (PAQ; Spence & Helmreich, 1979). From these instruments, we examined specific traits that have been shown to be related to CIT (e.g., Welkowitz et al., 1990). The 16PF was used to measure the personality attributes of *warmth* and *dominance* in parents, while the PAQ was used to measure parental *competitiveness* and *expressiveness*. Briefly, the 16PF is a self-report assessment instrument that measures 16 personality dimensions that include warmth, dominance, privateness, social boldness, and 12 others. The response format is multiple-choice and includes the response selections: (a) true; (b) unsure; and (c). false. Scores are standardized ("standardized ten" or "sten"), ranging from 1 to 10 with a mean of five and a standard deviation of two. Scores that fall farthest from the mean in either direction are considered extreme. The more extreme a score is toward a given pole, the more likely the trait will be seen in the individual's personality. The 16 PF has been shown to have test-retest reliability coefficients ranging from 0.69 to 0.83, and internal consistency ratings from 0.66 to 0.69.

The PAQ consists of 24 bipolar items, each of which is scored along a continuum ranging from 0 (not at all) to 4 (extremely). Individuals identify the number that best represents his or her personality characteristics. Items are then assigned to three 8-item scales corresponding to personality traits traditionally considered to be masculine (competitive), feminine (expressive) and masculine-feminine (socially desirable). Evidence of relatively high construct validity for the PAQ has been shown when the scales are used as measures of competitiveness and expressiveness (as in the present study; e.g., Helmreich, Spence & Wilhelm, 1981).

2.2. *Procedures*

All children participated in the initial testing session to assess their suitability for participation in the study (i.e., normal speech, language and hearing for all children; diagnosis of stuttering for children assigned to the experimental group). All testing sessions were conducted at the child's home, with his or her parents either watching quietly or in another room. Only children with speech, language and hearing skills that were within age-level expectations were invited to continue. In those cases, two subsequent sessions were scheduled at the child's home, in which each child interacted with either his or her mother or father during a semi-structured play activity. Session order was randomized for each child–parent pair.

Children and their parent conversed while sitting facing each other at a table in a quiet room in their home. No additional family members or pets were present in the room at the time of the recording, and other members of the household who were at home were asked to be as quiet as possible during recording. All interactions were video recorded for disfluency analysis, and audio recorded for AVTA analysis. The video camera (Sharp, VLL 490) was positioned far enough away from the participants so that it did not pose a significant interference to the natural flow of conversation (e.g., approximately 10 ft away).

An important consideration in collecting speech data for AVTA analysis is the unintended recording of either noise or a co-conversationalist's speech. Due to the nature of the data processing and measurement system inherent in the AVTA, there is obviously a chance for measurement error in cases where this occurs frequently. In order to reduce the probability of unwanted speech or extraneous noise pick-up, the child and parent were seated on opposite sides of a table, several feet from one another. In addition, both were fit with two microphones: a lapel microphone (ATR35s) placed on the clothing as close to the mouth as possible, and a headset microphone (Azden, WLX-Pro). The signals from the lapel microphones were fed into the video camera, while the signals from the headset microphones were fed into separate channels of a two-channel stereo cassette deck (Optimus SCT-86) for subsequent analysis by specialized software (described in the following section).

Prior to recording, each child–parent pair was instructed to talk about anything they would like for approximately 20 min, just as they would normally do. Each child–parent pair was provided with an assortment of Playdoh and told they could play with it if they wished. All situations were recorded in such a way that both parent and child could be observed simultaneously to ensure stable microphone placement.

3. Data analysis

3.1. Automatic vocal transaction analysis (AVTA) of parameters of vocal behavior

Separate audio signals for the both the child and parent (mother or father) served as input to a specialized computer system that allowed for the quantification of the sound and silence patterns in their simultaneous vocal behavior. This system is known as the automatic vocal transaction analyzer (AVTA). Developed by Jaffe and Feldstein and colleagues (e.g., Cassotta, Feldstein, & Jaffe, 1964a, 1964b; Jaffe & Feldstein, 1970; Jaffe et al., 2001; Feldstein, BenDebba, & Alberti, 1974; Feldstein & Welkowitz, 1987), the AVTA has been used extensively. It offers a high degree of precision in the analysis of parent–child interaction as it unfolds over time, and has shown to be highly reliable in quantifying sound and silence patterns in the speech stream across numerous published studies of adult–adult, parent–child, and child–child conversations (e.g., Beebe, Jaffe, Feldstein, Mays, & Alson, 1985; Cassotta et al., 1964a, 1964b; Warner, 1992a, 1992b; Welkowitz & Feldstein, 1969, 1970).

Briefly, the AVTA software performs an A-D conversion of both the child and parent audio signals. Both signals are sampled simultaneously every 0.250 s, to determine the presence ("on") or absence ("off") of an acoustic signal related to vocalization. The resulting patterns of sound and silence are subsequently coded to reflect different vocal states that can be attributed to the child, the parent, or both during conversation. In this system of codes, vocalizations are assigned "1," and silences are coded as "0." Finally, all coded intervals are stored digitally as a series of binary numbers that reflect four distinct dyadic states: "0" indicates that both the child and parent are silent; "1" indicates that the child is talking and the parent is silent; "2" indicates that the parent is talking and the child is silent, and "3" that both the child and the parent are talking at the same time. The average duration for each of the five vocal states within a fixed interval of time for each child–parent dyad is then calculated.

Parsing each parent–child interaction into these vocal states is accomplished through the "turn rule" (Jaffe et al., 2001). A turn (*T*) begins at the moment a participant begins vocalizing alone, continues while the person holding the floor speaks alone, and ends immediately prior to the instance that the other speaker begins speaking alone. It is, therefore, the time during which one participant has the floor. The five vocal states occurring within each turn include (after Feldstein & Welkowitz, 1987).

3.1.1. Vocalization (V)

A vocalization is a segment of speech uninterrupted by silences longer than 200 ms, uttered by the speaker who has the floor.

3.1.2. Pause (P)

A pause is an interval of joint silence bounded by the person who is speaking, and longer than 200 ms.

3.1.3. Switching pause (SP)

A switching pause is an interval of joint silence between two speaking turns that marks the change of speakers. A switching pause is initiated by the speaker who has the turn, and ends with a vocalization of the conversational partner. It is assigned to the person who relinquishes the floor.

3.1.4. Simultaneous speech

Simultaneous speech is speech uttered by a speaker who does not hold the floor (turn) during a vocalization produced by the person who has the floor. There are two forms of simultaneous speech: (a) *Interruptive simultaneous speech (ISS),* which is defined as part of a speech segment that begins while the person who holds the floor is talking and ends after he/she has stopped. Only the portion uttered by the person not holding the floor is considered simultaneous speech and is credited to him/her; and (b) *Noninterruptive simultaneous speech (NSS)*, which is defined as a speech segment that begins and ends while the person holding the floor is talking, does not result in a change of speakers, and is credited to the person who does not have the floor.

In the present study, we examined the duration of each of the different vocal state behaviors within turns, as well as the duration of the turns themselves, obtained from children and their parents in conversation. More importantly, we examined the lagged correlation or reciprocal coordination of these durations between each child and his/her parent. Vocal state durations were sampled and averaged every 5 s; thus, a 20-min conversation yielded mean durations from 12 five-second intervals per minute for 20 min, for a total of 240 intervals. To assess the degree of coordination between parent and child vocal state durations, time-series regression using lag procedures were used in data analysis, such that t represented current behavior (e.g., parent's averaged switching pause duration), $t-1$ represented that same behavior during the prior 5-s interval, and k equaled the number of prior time intervals. To determine the influence of the child's behavior on the parent's, and vice versa, squared semi-partial cross-correlation coefficients, or coefficients of CIT, were obtained for each vocal state in the parent–child interaction. Thus, CIT coefficients reflected the degree to which the duration of a vocal state of either the child or parent (e.g., switching pause) was influenced by, or coordinated with, the same behavior produced by the conversational partner during the previous five seconds. For example, a coefficient of 0.34 for vocalization duration for a given child during conversation with his mother suggests that approximately 34% of the variance of the child's behavior could be accounted for by the durations of his mother's vocalizations during the previous 5 s of conversation.

The squared cross-correlation coefficients, or coefficients of CIT, for each vocal state were subsequently submitted to Chi-square analysis (with d.f. equal to the number of Chi squares in the sum) to determine whether the group of coefficients was significantly different from zero. The steps used in this analysis were used by Jasnow et al. (1988) in their previously discussed study of CIT in interactions between children with Down syndrome and their mothers. First, standard normal deviate scores were obtained for the probability scores associated with the CIT coefficients. Second, these standard scores were squared, yielding a Chi-square with one degree of freedom. Finally, the Chi-squares for each group were summed to provide a Chi-square test with degrees of freedom equal to the number of Chi-squares in the sum; this determined whether the CIT coefficients in each group were significantly different from zero.

To determine whether the magnitude of CIT coefficients associated with each group were significantly different from one another, a multivariate analysis of variance (ANOVA) was conducted for each group, for all CIT coefficients associated with the five vocal states (e.g., coefficients for vocalization durations vs. coefficients for pause durations). Separate analysis of variance procedures (ANOVA) were used to make comparisons between the two groups of children (stuttering and nonstuttering) and parents to determine whether the magnitude of CIT coefficients were significantly different according to group affiliation (Jasnow et al., 1988),

3.2. Reliability

3.2.1. Reliability of AVTA measures

As discussed in the Introduction, the AVTA system has been used in numerous studies and has been found to provide a reliable measurement of the number and duration of the periods of vocalization and silence produced by two people as they talk with one another. In its earliest stages of development, Cassotta et al. (1964a, 1964b) conducted two studies to evaluate the reliability of the AVTA system. The first study consisted of a comparison of three separate AVTA analyses of the same audio taped two-minute speech samples, and the second study was a similar analyses conducted by a trained human operator. Product moment correlation coefficients provided reliability estimates for utterance frequency, total vocal time, and each of the vocal states (e.g., pause time, turn-switching pause). Reliability estimates for the AVTA ranged from 0.91 to 0.99 whereas those for the operator measurements ranged from 0.59 to 0.98. These reliability estimates are consistent with those observed in a number of studies using the AVTA and related methods that allow for sequential analysis of coded speech (e.g., Warner, 1992a, 1992b), suggesting that the AVTA produces highly reliable data from which frequency and duration of temporal parameters can be obtained.

From their reliability study, Cassotta et al. (1964a, 1964b) concluded that the AVTA system provides a high degree of measurement reliability across time, and that this reliability is consistently higher than that of a trained operator. In addition, these researchers noted that the trained operator's performance appeared to be "seriously impaired when the recording contains a high incidence of simultaneous speech, whereas the reliability of AVTA is not noticeably affected by this condition (p. 103)." They argued that the advantages of using an automated system become increasingly apparent when a large amount of simultaneous speech is present, as this presents an increase in task difficulty that can hamper the processing abilities of human operators. Finally, Cassotta et al. also observed that the reliability of AVTA is not hampered by the quality of the tape recording, which can often affect analysis relying on human perception.

3.2.2. Reliability of AVTA measures in the present study

Prior to data analysis and assessing reliability, all audio tapes were examined to assure that the signals were not contaminated by crosstalk or noise in the acoustic signals related to each speaker's output.

Reliability estimates for parameter values obtained for the present study were calculated for both sets of children and their respective parents in a manner similar to that described by Cassotta et al. (1964a, 1964b) Five randomly selected interactions were coded twice; correlation coefficients of correlation between samples for the children ranged from 0.798 to 0.999, while those for the parents ranged from 0.806 to 0.999.

3.2.3. Reliability of speech disfluency measures

Recall that for this study, a child was considered to be stuttering if he or she exhibited an average of three or more within-word or stuttering—like disfluencies (SLD; e.g., sound-syllable repetitions, sound prolongations) and/or monosyllabic whole-word repetitions per 100 words of conversational speech. Cohen Kappa test (K) for reliability was used because of its ability to indicate the proportion of agreement present after chance agreement has been eliminated. Kappa values between 0.4 and 0.6 represent fair agreement, values between 0.6 and 0.75 represent good agreement, and values greater than 0.75 indicate very good or excellent agreement (e.g., Cordes, 1994).

3.2.4. Intra-judge

All instances of speech disfluency in three contiguous 100-word samples of each child's interaction with his or her mother were originally identified and coded by the principle investigator. One year later, the investigator re-analyzed 20% of these samples, selected randomly. The Kappa value for intra-judge reliability of stuttering type was $K = 0.684$ ($p < 0.01$), which indicated good agreement.

3.2.5. Inter-judge

Inter-judge reliability for the identification of stuttering type was determined by comparing the ratings of the investigator to those of a graduate student in speech-language pathology who had completed a graduate course in fluency disorders, and had classroom and clinical experience in the analysis of speech disfluencies in children. Prior to initiating reliability procedures, the student participated in guided training, during which types of disfluencies were defined by the first investigator. Subsequently, the student was asked to measure the frequency of speech disfluency types from audio-recorded speech samples of stuttering and non-stuttering children who were not subjects in the present study. Feedback and repeated listening (no more than three times) was used to clarify points of disagreement. Once 90% interjudge agreement was reached for these samples, the student analyzed 20% of the recorded parent–child speech samples used in the present study, chosen at random. The Kappa value for inter-judge reliability of stuttering type was $K = 0.69$ ($p < 0.01$), which indicated good agreement.

4. Results

The main purpose of this study was to use an established method for analyzing the presence and nature of reciprocal influence or CIT of vocal state durations in the conversations of children who stutter and their parents. We used a matched group of nonstuttering children and their parents for comparison data that would help us to interpret the results of this analysis. The results will be presented with regards to directionality of significant CIT in the parent–child dyads. That is, CIT is considered to be unidirectional if the coefficient for a particular vocal state (e.g., pauses) is significant for one member of the dyad (e.g., child), but not the other, and is bi-directional if the coefficient is significant for both members (Jaffe et al., 2001).

4.1. Mother–child and father–child comparisons of turn and vocal state duration

In the present study, we were primarily interested in lagged correlations between parent and child behaviors in conversation, but the means and standard deviations of the vocal state behaviors for both children and parents was also examined to assess the degree to which they compared to the different, but related measures analyzed in earlier studies.

Tables 2–5 provide summary statistics (means and standard deviations) for turn and vocal state durations obtained from the interactions between stuttering and nonstuttering children and their parents. First, it is important to note that with the exception of turns, the parent–child conversations analyzed in this study were comprised of alternating vocal states that were one second or less in duration. When collapsing across child and parent groups, the average turn durations for children ranged from approximately 3.5 to 4.5 s, and from 2.5 to 3.5 s for parents. These results are similar to those reported by Jasnow and Feldstein (1986) for infant–mother interaction, and serve to further emphasize the rapid tempo that characterizes conversational exchange.

Multiple independent *t*-tests (two-tail) for each vocal state for each dyad group (e.g., vocalization duration for CWS and their mothers) were performed with adjusted alpha for multiple comparisons (Bland & Altman, 1995). Results of this analysis showed no significant differences for any of the vocal states for any of the parent–child dyad groups (experiment-wise error rate = 0.30; p (adjusted) = 0.008). It should be noted, however, that three comparisons approached, but did not reach significance. For example, the average duration of children's turns was longer than that of their fathers overall, and approached significance for children who stutter as com-

Table 2
Descriptive statistics

Children who stutter (CWS) and their mothers			
Vocal state	CWS	Mothers	t
Turn			
M	3.988[a]	3.012	1.49
S.D.	1.920	0.770	
Vocalization			
M	1.459	1.372	0.79
S.D.	0.291	0.196	
Pause			
M	0.860	0.941	0.71
S.D.	0.284	0.291	
Switching pause			
M	0.837	0.881	0.29
S.D.	0.380	0.294	
Noninterruptive simultaneous speech			
M	0.465	0.433	0.78
S.D.	0.096	0.086	
Interruptive simultaneous speech			
M	0.323	0.335	0.65
S.D.	0.034	0.055	

[a] All measures in seconds.

Table 3
Descriptive statistics

Children who do not stutter (CWDNS) and their mothers			
Vocal state	CWDNS	Mothers	*t*
Turn			
M	3.737[a]	3.210	0.08
S.D.	1.418	1.238	
Vocalization			
M	1.257	1.486	1.9 $p < 0.05$
S.D.	0.180	0.284	
Pause			
M	1.022	1.067	0.45
S.D.	0.408	0.218	
Switching pause			
M	1.002	1.064	0.23
S.D.	0.337	0.304	
Noninterruptive simultaneous speech			
M	0.431	0.463	0.76
S.D.	0.039	0.113	
Interruptive simultaneous speech			
M	0.341	0.339	0.05
S.D.	0.070	0.066	

[a] All measures in seconds.

Table 4
Descriptive statistics

Children who stutter (CWS) and their fathers			
Vocal state	CWS	Fathers	*t*
Turn			
M	4.582[a]	2.395	2.77 $p < 0.005$
S.D.	2.291	0.947	
Vocalization			
M	1.406	1.127	2.10 $p < 0.05$
S.D.	0.348	0.224	
Pause			
M	1.029	1.012	0.10
S.D.	0.425	0.305	
Switching pause			
M	0.904	0.972	0.52
S.D.	0.235	0.316	
Noninterruptive simultaneous speech			
M	0.413	0.440	0.53
S.D.	0.110	0.107	
Interruptive simultaneous speech			
M	0.323	0.322	0.07
S.D.	0.027	0.071	

[a] All measures in seconds.

Table 5
Descriptive statistics

Children who do not stutter (CWDNS) and their fathers			
Vocal State	CWDNS	Fathers	t
Turn			
M	4.640[a]	3.445	1.32
S.D.	2.091	1.458	
Vocalization			
M	1.350	1.206	0.62
S.D.	0.443	0.482	
Pause			
M	1.113	1.232	0.55
S.D.	0.456	0.409	
Switching pause			
M	1.113	1.189	0.34
S.D.	0.545	0.351	
Noninterruptive simultaneous speech			
M	0.365	0.373	0.09
S.D.	0.168	0.179	
Interruptive simultaneous speech			
M	0.297	0.332	1.33
S.D.	0.043	0.060	

[a] All measures in seconds.

pared to their fathers ($t = 2.77$; $p < 0.05$). Further, as Tables 3 and 4 show, CWDNS produced shorter vocalization durations than their mothers in conversation ($t = 1.9$; $p < 0.05$), and CWS produced longer vocalization durations than their fathers ($t = 2.10$; $p < 0.05$). These findings support prior work in CIT between children and parents (e.g., Welkowitz et al., 1990) which showed that absolute vocal state durations of the parents and the children in parent–child dyads are quite equivalent. The extent and direction to which parents and children in the present study coordinated or attuned their vocal behaviors to the other will be discussed in the following section.

4.2. Bi-directional influence in parent–child conversation

Tables 6–9 contain the results of Chi-square analysis of times series regression for each of the dyad groups. As shown, evidence for mutual influence or significant interpersonal accommodation (Jasnow & Feldstein, 1986) was observed more frequently for CWS and their parents than for CWDNS and their parents. In mother-CWS dyads, the duration of both the child's and the mother's simultaneous speech (both noninterruptive and interruptive) influenced the duration of these vocal states in the subsequent speech of their partner. No significant mutual influence was observed in the interactions between CWDNS and their mothers, for any of the vocal states. For father-CWS dyads, significant bi-directional accommodation was seen for both pause duration and the duration of interruptive simultaneous speech, while in CWDNS-father dyads mutual influence was observed for turn-switching pause durations alone.

Table 6
Chi-square analysis of time series regression

Children who stutter (CWS) and their mothers				
Vocal state	N[a]	χ^2	p	R[b]
CWS				
Turn	10	8.8	ns	0.23
Vocalization	10	25.2	<0.005	0.24
Pause	10	17.7	ns	0.24
Switching pause	10	31.1	<0.005	0.27
Noninterruptive simultaneous speech	10	24.7	<0.005	0.24
Interruptive simultaneous speech	10	20.7	<0.05	0.23
Mothers				
Turn	10	29.01	<0.05	0.31
Vocalization	10	15.5	ns	0.25
Pause	10	11.7	ns	0.22
Switching pause	10	11.4	ns	0.23
NonInterruptive simultaneous speech	10	27.6	<0.005	0.22
Interruptive simultaneous speech	10	26.1	<0.005	0.24

[a] d.f. for the Chi-square is equal to simple size.
[b] R = average standardized partial regression coefficient.

4.3. Unidirectional influence in parent–child conversation

4.3.1. Children

While mutual influence was observed in a total of three of the five vocal states across all dyads, as Tables 6–9 reveal, significant unidirectional CIT was more pervasive, especially for the children who stutter. For example, while talking with their mothers, CWS exhibited significant

Table 7
Chi-square analysis of time series regression

Children who do not stutter (CWDNS) and their mothers				
Vocal state	N[a]	χ^2	p	R[b]
CWDNS				
Turn	10	8.5	ns	0.23
Vocalization	10	3.0	ns	0.20
Pause	10	5.8	ns	0.22
Switching pause	10	50.5	<0.005	0.30
Noninterruptive simultaneous speech	10	45.4	<0.005	0.26
Interruptive simultaneous speech	10	3.04	ns	0.20
Mothers				
Turn	10	17.7	ns	0.23
Vocalization	10	20.8	<0.05	0.25
Pause	10	10.9	ns	0.24
Switching pause	10	10.9	ns	0.25
Noninterruptive simultaneous speech	10	18.1	ns	0.21
Interruptive simultaneous speech	10	31.2	<0.005	0.25

[a] d.f. for the Chi-square is equal to simple size.
[b] R = average standardized partial regression coefficient.

Table 8
Chi-square analysis of time series regression

Children who stutter (CWS) and their fathers				
Vocal state	N[a]	χ^2	p	R[b]
CWS				
Turn	10	18.4	<0.05	0.27
Vocalization	10	13.2	ns	0.25
Pause	10	21.1	<0.05	0.26
Switching pause	10	22.2	<0.05	0.25
Noninterruptive simultaneous speech	10	31.1	<0.005	0.26
Interruptive simultaneous speech	10	23.6	<0.01	0.27
Fathers				
Turn	10	7.2	ns	0.21
Vocalization	10	16.4	ns	0.23
Pause	10	26.3	<0.05	0.27
Switching pause	10	9.9	ns	0.23
Noninterruptive simultaneous speech	10	5.1	ns	0.19
Interruptive simultaneous speech	10	14.6	ns	0.24

[a] d.f. for the Chi-square is equal to simple size.
[b] R = average standardized partial regression coefficient.

CIT for: durations of vocalization and turn-switching pauses. As previously described, mutual influence was the case for both types of simultaneous speech (noninterruptive and interruptive), but CWS also coordinated their vocalization and switching-pause durations with their mothers. Unidirectional temporal accommodation for CWS was even more frequent in their interactions with their fathers. While mutual influence was observed for pause duration and interruptive simultaneous speech, these same children achieved significant CIT with their fathers for turns as well as turn-switching pauses and noninterruptive simultaneous speech.

Table 9
Chi-square analysis of time series regression

Children who do not stutter (CWDNS) and their fathers				
Vocal state	N[a]	χ^2	p	R[b]
CWDNS				
Turn	10	7.8	ns	0.23
Vocalization	10	13.2	ns	0.25
Pause	10	6.10	ns	0.23
Switching pause	10	36.9	<0.05	0.28
NonInterruptive simultaneous speech	8	9.29	ns	0.24
Interruptive simultaneous speech	10	22.5	<0.05	0.21
Fathers				
Turn	10	8.2	ns	0.20
Vocalization	10	7.9	ns	0.22
Pause	10	4.4	ns	0.22
Switching pause	10	19.5	<0.05	0.26
Noninterruptive simultaneous speech	8	16.9	<0.05	0.20
Interruptive simultaneous speech	10	14.3	ns	0.29

[a] d.f. for the Chi-square is equal to simple size.
[b] R = average standardized partial regression coefficient.

CWDNS, on the other hand, exhibited no significant mutual accommodation with their mothers, and significant unidirectional CIT for only two vocal states while talking with their mothers: switching pauses and noninterruptive simultaneous speech. Further, these same children and their fathers engaged in mutual influence for switching-pause durations, and the children exhibited significant CIT with their fathers for interruptive simultaneous speech. This observation indicates that CWDNS were influenced by the duration of interruptive simultaneous speech in their father's previous turn, but not vice versa.

Overall, findings suggest that while talking with their mothers and fathers, CWS were more likely than CWDNS to coordinate with, or accommodate to, the temporal patterns of their periods of speaking and silence with those produced by their parents in preceding utterances, and that children who stutter and their parents are more likely to exert mutual influence.

4.3.2. Mothers

As previously discussed, the CWS in this study and their mothers exhibited mutual influence for both forms of simultaneous speech, both noninterruptive and interruptive. In addition, as shown in Table 6, the mothers of CWS exhibited significant CIT for turn durations. In other words, as their children increased and/or decreased the duration of their turns, their mothers followed suit in their subsequent turns. In sum, in mother-CWS conversations, temporal synchrony or coordination of the duration of vocalizations, switching pauses and turns was unidirectional in that either the children (vocalizations and switching pauses) or mother (turns), was influenced by the other, but not vice versa. Finally, while there was no significant mutual influence in mother-CWDNS dyads, the mothers of these children exhibited coordinated interpersonal timing for both vocalization and interruptive simultaneous speech duration.

4.3.3. Fathers

The fathers of both CWS and CWDNS were influenced by different vocal states than the mothers. Specifically, during conversation, the fathers of CWS coordinated the duration of their pauses with those of their child during previous conversational turns, while the fathers of CWDNS coordinated the duration of their noninterruptive simultaneous speech and switching pauses.

4.4. Degree of coordinated interpersonal timing

Results of multiple analyses of variance revealed no significant differences in the *degree* to which CIT was achieved for the duration of different vocal states across the two groups of children and two groups of parents. However, when the groups of children were combined (stuttering and nonstuttering children), ANOVA results indicated that a significant effect for parent type was observed for vocalization duration ($F(1, 32) = 6.62$, $p = 0.01$). Both groups of children, regardless of whether they stuttered or were normally disfluent, exhibited a greater degree of CIT for vocalization durations during conversations with their fathers than with their mothers.

4.5. Personality attributes of children: comparison of children who do and do not stutter

4.5.1. Personality inventory for children (PIC)

The *family relations, withdrawal* and *social skills* scales from the PIC were examined because of previous work suggesting that these or very similar constructs are related to CIT (e.g., Welkowitz & Kuc, 1973). The family relations scale measures family effectiveness and cohesion with regard to such factors as communication between parents, parent participation in and expectations about

Table 10
Personality inventory for children (PIC)

Scores for children who do stutter (CWS) and children who do not stutter (CWDNS)			
Subject	Family relations	Withdrawal	Social skills
CWS			
S1	58	43	55
S2	42	46	70
S3	64	46	51
S4	46	55	50
S5	53	68	57
S6	46	43	45
S7	62	43	57
S8	46	47	52
S9	73	51	46
S10	58	46	58
CWDNS			
S1	46	43	39
S2	45	71	46
S3	45	51	41
S4	49	43	37
S5	42	51	37
S6	57	38	32
S7	46	55	55
S8	42	47	47
S9	48	46	46
S10	48	56	62

child – rearing, and general home atmosphere. Elevated *family relations* scale scores reflect increased marital instability and conflict, and decreased effectiveness in disciplining children in the home. The *withdrawal scale* measures participation in social contact. Elevated scores reflect a child's increased social withdrawal and isolation; highly elevated scores reflect more extreme withdrawal and isolation, and also indicate social discomfort. The *social skills* scale measures success in social activities with peers. Elevated social skill scores reflect a child's difficulty in making and keeping friends.

Table 10 shows the family relations, social skills, and withdrawal scale scores for the children who stutter and their nonstuttering peers, respectively. Independent samples t-tests (two-tail) revealed significant between-group differences for both family relations and social skills ($t = 2.25$; $p < 0.05$, $t = 2.69$; $p < 0.05$, respectively), but not for withdrawal ($t = 0.34$; $p > 0.05$). That is, as a group the children who stutter obtained significantly higher scores for both family relations and social skills scales, indicating that their homes were characterized by greater marital discord as compared to those of the children who do not stutter, and they had more difficulty than the nonstuttering children in making and maintaining friendships.

4.6. Personality attributes of parents: comparison of mothers and fathers of children who do and do not stutter

4.6.1. Personality attributes questionnaire (PAQ) and 16 PF

Tables 11 and 12 show the competitiveness and expressiveness (PAQ) raw scores, and warmth and dominance (16PF) standard scores for the mothers and fathers of both groups of

Table 11
Personality attributes questionnaire (PAQ) and 16 PF scores

Mothers and fathers of children who stutter (CWS)								
CWS	PAQ		16 PF		PAQ		16 PF	
	Mother comp.	Mother expr.	Mother warmth	Mother dom.	Father comp.	Father expr.	Father warmth	Father dom.
S1	18	21	2.5	4	21	18	3	4
S2	17	24	4.5	4	21	21	4	1
S3	21	19	4.5	5	21	19	2	3
S4	20	27	6	5	20	17	5	7
S5	16	24	7.5	1	24	21	8.5	7
S6	16	23	6	2	17	20	7	7
S7	20	24	4	5	18	21	5	6
S8	21	23	3	5	20	24	4	5
S9	26	31	8.5	7	14	23	6	3
S10	18	27	7	4	21	19	7	8

Comp.: competitiveness; expr.: expressiveness; dom.: dominance.

children, respectively. For both the competitiveness and expressiveness scales of the PAQ, a higher score in either reflects an increased tendency to exhibit that personality trait. For the 16PF, higher scores on the warmth scale reflect an outgoing nature and tendency to be more attentive to others, while elevated dominance scores reflect a forceful and assertive personality.

Independent samples *t*-tests (two-tail) revealed no significant differences between the two groups of mothers or the two groups of fathers in either competitiveness ($t = 0.36$; $p > 0.05$ (mothers); $t = 1.38$; $p > 0.05$ (fathers)), expressiveness ($t = 0.50$; $p > 0.05$ (mothers); $t = 0.86$; $p > 0.05$ (fathers)), warmth ($t = 0.67$; $p > 0.05$ (mothers); $t = 0.92$; $p > 0.05$ (fathers)), or dominance ($t = 1.28$; $p > 0.05$ (mothers); $t = 0$; $p > 0.05$ fathers)).

Table 12
Personality attributes questionnaire (PAQ) and 16 PF scores

Mothers and fathers of children who do not stutter (CWDNS)								
CWDNS	PAQ		16 PF		PAQ		16 PF	
	Mother comp.	Mother expr.	Mother warmth	Mother dom.	Father comp.	Father expr.	Father warmth	Father dom.
S1	18	24	8.5	4	21	22	6	6
S2	20	25	3	4	21	23	4	3
S3	17	24	5	2	18	14	1.5	5
S4	19	24	7.5	6	20	20	2.5	4
S5	21	26	7.5	6	21	21	5.5	7
S6	21	21	9	10	24	26	4	4
S7	23	17	3.5	10	17	25	4	2
S8	21	25	4.5	6	26	23	6.5	9
S9	19	28	8	3	22	21	6	6
S10	18	24	3.5	4	24	19	4	5

Comp.: competitiveness; expr.: expressiveness; dom.: dominance.

4.7. Relationship between child personality factors and CIT

As an initial attempt to examine potential relationships between personality attributes of the children is this study and CIT, we conducted a stepwise multiple regression analysis using family relations, social skills and withdrawal as predictor variables of the CIT coefficients. Separate multiple regression equations were calculated for each of the five vocal state durations, and for turn duration, resulting in 24 separate regression equations (i.e., six temporal measures × two conversational samples (mothers and fathers) × two groups (CWS and CWDNS). To control for the experiment-wise error rate, a corrected alpha of .025 was used. The single best predictor of CIT was found to be the social skills score for children who stutter and the CIT coefficient for noninterruptive simultaneous speech in conversations with their fathers ($R = 0.61$, $p = 0.005$). When both family relations and withdrawal scores were added, there was slightly more predictive value, but less significance ($R = 0.66$; $p = 0.023$). Taken with the results of the between-group comparisons which indicated that the CWS who exhibited higher social skills scores (and therefore had more difficulty with social interaction), these findings suggest that the more difficulty these children had with social activities, the more they coordinated their noninterruptive simultaneous speech with their fathers.

5. Discussion

There were two principal findings from this study. The first is that with few exceptions, parents and their children do not differ in the durations of various vocal states while they talk with each other. This was observed for both the stuttering and nonstuttering children and their parents who participated in this study. The second main finding is that children who stutter and their parents were more likely than nonstuttering children and their parents to show mutual accommodation during conversation. That is, CWS and their parents were more likely than nonstuttering child–parent dyads to be significantly influenced by the temporal characteristics of their partner's vocal timing during their subsequent conversational turns. This is particularly the case for the duration of simultaneous speech, or what Kelly and Conture (1992) described in their studies of stuttering child–parent interaction as "simultalk." In the present study, there was evidence for mutual influence for both noninterruptive and interruptive simultaneous speech when the children who stutter engaged in separate conversations with their mothers and their fathers. In general, when fathers or mothers of the stuttering children interrupted their child, the child was inclined to interrupt in the subsequent turn for a similar amount of time, and vice versa. Finally, results indicated that in general, the CWS were more likely to be influenced by the temporal characteristics of their father's, as opposed to their mother's speech during conversational interaction.

The results from this study add a new dimension to our understanding of stuttering intervention approaches that focus on training parents to reduce various sources of communicative time pressure when talking with their young children who stutter (e.g., Starkweather & Gottwald, 1990). In particular, present findings serve to move us away from the notion that the parents of children who stutter "talk too fast," or "interrupt too much," and toward an appreciation of how we might exploit the normal phenomenon of mutual accommodation in parent–child conversations as a way to facilitate the child's fluent speech production. That is, taken together with the observation that parental use of shorter and slower utterances (turns and vocalizations), and longer switching pauses can be fluency facilitating for some children who stutter (e.g., Bernstein Ratner, 1992; Guitar et al., 1992; Zebrowski et al., 1996), findings from this study provide support for stuttering therapy approaches for children that emphasize parent manipulation and modeling of temporal characteristics of parent–child interaction. In addition, these findings lend insight into why such approaches might be efficacious. For example, in a recent study two well-known types of stuttering therapy for preschool children were compared to assess their effect on stuttering frequency and severity, as well as the extent to which parents found the approach satisfactory (Franken, Kielstra-Van der Schalk, & Boelens, 2005). Both approaches are administered by the child's parents. One program uses operant procedures (i.e., Lidcombe Program; Onslow, Andrews, & Lincoln, 1994), which require parents to provide verbal contingencies during conversation with their child, such that fluent productions are praised, and disfluent speech is followed by a request to say the disfluent word fluently. The second approach, also known as the "demands-capacities" model, (Starkweather, 1997) requires, among other things, parent modeling of shorter conversational turns characterized by a slow speech rate, longer pauses, and longer switching pauses. Results indicated that both the operant-based and "demands-capacities" approach resulted in measurable increases in speech fluency for children. To some extent, findings from the presents study support the argument that one of the reasons why parent manipulation of certain temporal speech parameters is fluency enhancing is because some children who stutter may be more likely to attune the durations of their vocal state behaviors to those of their parents in conversation. It is clear that future studies of turn-by-turn coordination or influence, not just overall rate difference or changes across interactions, will help us to better understand the mechanisms by which parent and clinician modeling may affect fluency.

The children who stutter in the present study and their parents exhibited more pervasive coordinated interpersonal timing than did the nonstuttering children and their parents during conversation. This observation can be attributed to any number of factors, including the combined influence of both the child's and the parents' level of sensitivity to internal and external stimuli or behavior, and the degree to which they perceive unpredictability in either the interaction, or their relationship.

5.1. Sensitivity

It has been noted that conversational dyads marked by significant levels of CIT typically contain at least one participant who is likely to exhibit behaviors consistent with a heightened sensitivity to both internal and external (environmental) stimuli, across temporal and sensory domains (e.g., Hane et al., 1996; Hane, Feldstein, & Dernetz, 2003; Oyler, 1996). Of late, the contribution of temperament to the onset and development of stuttering in children has received attention in the literature. Early work in this area has shown that as a group, young children who stutter tend to be described by their parents as "highly sensitive" to a number of internal and external variables, and that this sensitivity was present during the time of stuttering onset, i.e., ages three to four years (Bloodstein, 1995; LaSalle, 1999; Oyler, 1996, 1999; Rustin, Botterill, & Kelman, 1996). More recently, Anderson et al. (2003) used the *Behavioral Style Questionnaire* (McDevitt & Carey, 1987) to show that young children who stutter are more inclined than their nonstuttering counterparts to exhibit a temperamental profile characterized by hypervigilance (i.e., less distractibility), nonadaptability to change, and irregular biological functions. While temperament per se was not assessed in the present study, it seems reasonable to speculate that the higher score on the social skills scale observed for the stuttering children might be related not only to difficulty in forming friendships with peers, but also to a heightened sensitivity when interacting with peers and adults, including their parents. Add to this the observation that children who stutter tend to be relatively slow to change behavior during new situations, or situations they may perceive to be relatively unpredictable, and that they are less easily distracted. The combined effect might be a tendency for some children who stutter to more easily, quickly or strongly 'synchronize' the temporal aspects of their vocal behaviors with those of their parents, as a way of establishing a communicative 'comfort zone' during interaction (Anderson et al., 2003). This so-called 'strategy' may serve an adaptive purpose in that it is likely to facilitate speech fluency (i.e., children who stutter typically exhibit increased frequency of speech disfluency when speaking in real or perceived novel situations. On the other hand, it may be the case that the production of stuttered speech combined with a nonadaptive, hypervigilant temperament and a high degree of CIT across a number of temporal speech parameters, leads to a generalized pattern of communication avoidance and self-imposed restriction on the part of the child.

5.2. Unpredictability

Main and Solomon (1986) and Moore (1994, as cited in Feldstein, 1998) observed that parent infant dyads characterized by highly unpredictable behavior on the part of the mother, or the child's perception of increased unpredictability, engaged in relatively "high" levels of coordinated interpersonal timing. Feldstein (1998) suggested that "high" degrees of attunement between parents and their infants may indicate the presence of problems in the interaction, and further speculated that infants may attempt to manage unpredictability by engaging in coordinated interpersonal timing with their mothers as a regulatory mechanism. In parent–stuttering child dyads, the occurrence of stuttering may be an additional source of unpredictability from both the child's and the parent's perspective.

Additional sources of unpredictability may stem from the ways in which the child's skills and abilities interact with his or her environment. For example, Crown (1991) found that "unacquainted" pairs of individuals engage in the greatest degree of mutual accommodation, followed by dyads consisting of individuals who "dislike" one another, and individuals who "like" one another. That is, it appears that co-conversationalists who are the least acquainted and/or the least comfortable with one another, are more likely to show greater amounts of coordinated interpersonal timing of their vocal behaviors in conversation. Recall that the children who stutter in the present study were characterized by poorer social skill development when compared to their nonstuttering peers. Further, their families were characterized by greater amounts of marital discord than were the families of the nonstuttering children in the study. As well, regression analyses suggested that for CWS, increased difficulty in social skills predicted a higher tendency to coordinate the duration of their interruptions with those of their father in conversation. The same was true when poor family relations and a tendency for the child to withdraw are added. This observation makes it reasonable to speculate that some CWS may perceive that their relationships with others (e.g., parents or other children), as well as the relationship between their parents, are difficult and often unpredictable. As such, these children may be more likely to attune their vocal behaviors as part of an overall management strategy, similar to what "unacquainted" pairs of individuals do, or dyads who "dislike" each other may do as well.

In conclusion, the findings from the present study suggest the need to examine the interrelationship between child factors (temperament, most notably), parent and family factors (personality, temperament, parenting practices, parent relationships and so forth) and their influence on conversational synchrony in the interactions between children who stutter and their parents. In particular, there is a need to understand the extent to which any or all of these factors might predict treatment responsiveness, especially with regard to therapy approaches that encourage parents to modify their speech when talking with their child. Finally, given that lack of CIT, or reduced strength of CIT has been observed in parent–child dyads where the child has specific learning or emotional problems, it might be the case that for some children who stutter, the amount and degree of CIT (both uni- and bi-directional) may be predictive of stuttering recovery or persistence.

5.3. Caveats

Like most research, there are limitations to the present study that need to be considered in the interpretation of the results reported here. The first is related to potential sources of error in the electronic processing of speech performed by the AVTA. As such, it is important to reiterate that the AVTA system was developed as a way to take a complex and multifaceted behavior such as speech and derive a simple string of behaviors (i.e., vocalization and silence) that could be submitted to binary coding and used as a global indication of mutual influence in conversation. Needless to say, such a "chronometric" analysis describes only one facet, or channel of the "full package" of speech (Feldstein, 1998: p. 183). The sequences of sound and silence are naturally limited in that they carry no suprasegmental features such as loudness, pitch, or syllabic stress, nor do they carry semantic, syntactic, phonological or phonetic information. By design, the AVTA is intended to strip away these features and maintain only the temporal patterns of the speech stream, represented as a relatively simple sequence of tones and silences of varying duration, but at a single frequency and decibel level (Feldstein, 1998).

The transformation of complex speech in dialogue into such a pared-down signal can, of course, contribute to measurement errors in the AVTA analysis. One of the most obvious is the collapsing of speech and nonspeech vocal behaviors such as laughing or coughing into a single stream that is interpreted to be speech. A second source of potential measurement error may stem from the 0.250 s sampling rate that has been conventionally used in prior work, and was also used in the present study. This sampling rate has the potential to lead to under- or overestimated durations of either a period of vocalization or pause, depending on where the sampling interval begins and ends. Such an error may be further compounded in the rare case that a child's speech contains voiceless speech segments in excess of 250 ms (e.g., voice-onset or stop-closure associated with stop consonants; e.g., Zebrowski, Conture & Cudahy, 1985). In these cases, such periods of voicelessness might be misinterpreted as a between- or within-turn pause. While aggregating speech and nonspeech vocal behaviors and sampling limitations may contribute to some measurement error, it is reasonable to assume that any error stemming from these procedures was evenly distributed across the subject groups in this study.

Finally, it is possible that any speech disfluency produced by the participants in the present study may have contributed to measurement error to some extent. In particular, the effects that stuttering, a disorder characterized by disruptions in speech timing, may have on AVTA coding of sound-silence sequences and subsequent analysis should be taken into account as a potential source of error. Take for example those cases where the child who stutters produces inaudible sound prolongations, so-called blocks, or dysrhythmic phonation during the production of a word or words within a conversational turn. When these disruptions occur within a sampling interval, they are likely to be coded as a pause either between or within a turn. As well, if they occur at the beginning or end of a sampling interval they will lead to an underestimated turn or vocalized state duration, or an overestimated turn-switching pause attributed to either partner depending on the location of the disfluency. It is here that any measurement error had the most potential to influence the present results, as such errors may have been disproportionately distributed across the groups of children (i.e., CWS as compared to CWDNS). However, as Feldstein (1976, 1988) has shown, the sound and silence sequences derived from AVTA analysis "yield a measure that is quite significantly related to global speech rate (1988; p. 165)," where global rate is a measure of words per minute with all pauses and disfluencies included. As such, the current results suggest that the presence of disfluencies in the speech of CWS in this study did not serve to distinguish their vocal state durations from either CWDNS or the four groups of parents (see Tables 2–5), nor did they likely result in a significantly slower speaking rate for these children. If such were the case, one might expect to find less evidence of coordinated interpersonal timing for the group of CWS, and such was not the case. Finally, it should be noted that seven of the ten CWS produced sound/syllable repetition as their primary disfluency type, and thus there was relative consistency in the type of stuttering behavior produced across the group of CWS. As such, one might assume that the stuttering children in this study produced disfluencies that were roughly equivalent in type and duration, and the number and severity of physical concomitants or associated behaviors; if that is in fact the case, then the likelihood of any measurement error being equally distributed across the group of children who stutter would be increased.

These potential sources of error are obvious limitations of the AVTA system, and need to be taken into account in any study using this methodology. That being said, it is important to reiterate that the AVTA was developed to create an admittedly over-simplified version of speech in dialogue for the specific purpose of looking at the phenomenon of synchrony or attunement in conversation and nothing more. The numerous studies that have used the AVTA and so-called "spin-off" systems (e.g., Warner, 1992a, 1992b) have shown that this method yields robust, replicated findings for reciprocal influence in on-off patterns of vocalization and silence across ages, dyads, and populations (normal and special needs). As discussed previously, the reliability of the AVTA system for measuring vocal state durations has been assessed a number of times in different ways (see Method). Further, while results might differ as a function of the duration of dialogue blocks used for analysis (e.g., in the present study we used 12 five-second blocks per minute for a total of 240 blocks in a 20 minute conversation, while others have used 10-s blocks), different sampling frequencies ranging from 0.250 to 10 s have yielded highly correlated measures of vocal state duration. In other words, as Warner (1992a, 1992b) convincingly showed, vocal activity from the same conversations sampled at both three times per second and once every 10 s were so highly correlated "as to be virtually indistinguishable (p. 58)."

An additional limitation of this study has to do with the relatively small sample size and the resulting reduction in statistical power typically thought to be associated with small samples. One way to evaluate the extent to which this may be salient for a particular study is to consider effect size. Whether or not an effect is consequential depends on consideration of two things: the specific context in which it occurs, and the p value assigned (e.g., Cox, 2005). The CIT coefficient used in the present study (R-squared) is arguably one of the most versatile and widely used measures of effect size. It was used to examine the proportion of the variance shared by two variables (in this case, a particular vocal state duration for a parent and child within the same dyad), which is the standard way to assess the phenomenon of reciprocal influence in conversational dyads. The observed strength of those correlations found to be significant in the present study are very similar to those reported in almost all of the prior studies that have been described in the literature review (e.g., Jasnow et al., 1988; Welkowitz et al., 1990, to cite just a few). In considering these factors, our view is that the significant results of this study "make sense" for the purposes of this study, and we speculate that using a larger sample size would yield at least similar, if not more robust findings.

5.4. Future research

As we discussed earlier in this paper, the logical next step in studying the importance of CIT to childhood stuttering is to examine its relationship to the behavior of stuttering using AVTA analysis. The first question of interest is: To what extent do the frequency, type and duration of stuttering effect CIT in either a reciprocal or compensatory manner? For example, are there differences in CIT across subgroups of CWS who differ according to frequency, type and duration of disfluency, and if so, is such influence reciprocal or compensatory? The use of subgroups can also be used to answer questions about how stuttering may effect the extent to which one's own behavior (in this case, that of CWS) can be predicted from the past behavior of the same speaker, a contingency referred to as an internal determinant (Warner, 1992a, 1992b). For example, is CIT differentially affected by either very high or very low levels of stuttering in conversations with his or her parent?

A question that has been discussed in several places in this paper has to do with the influence that parent speech rate across a conversation and across time (i.e., conversations across days, weeks or months) may have on the rate of CWS, and whether any change in rate affects stuttering. One way to begin to address this question is through the experimental manipulation of parent speaking rate, using the same or similar methods employed in previous work (e.g., Guitar & Marchinkoski, 2001; Zebrowski et al., 1996). Besides the lagged CIT coefficients themselves, additional dependent variables might include a measure of global or overall speaking rate derived from AVTA analysis (see Feldstein, 1998) as well as standard measures of disfluency across an interaction or within utterances. Further, as previously suggested, the findings from this study support the notion that temperament and other psychological or psychosocial traits are important to the attainment of CIT. Given that, the specific temperamental characteristics observed for CWS may impact CIT in such a way that it negatively affects social interaction. Further research should include additional measures of temperament that have been used in previous research with CWS (e.g., Anderson et al., 2003) to see whether specific temperamental profiles can predict the presence and strength of CIT for both social (between speaker) and internal (within speaker) determinants (Warner, 1992a, 1992b). Finally, it would be interesting to examine the relationship between physiological rhythms and the predictability of expressive behaviors such as vocal state durations in CWS. Both Chapple (1970) and Warner (1992a, 1992b) have suggested that the predictable patterns of vocal state durations that have been observed in studies of CIT may be cyclical. In an attempt to study this phenomenon, Warner (1992a, 1992b) used both time-series (i.e., temporal) and frequency domain analysis methods to examine on-off vocal activity derived from a system similar to the AVTA. Results indicated that these measures are correlated and that they reflect complementary characteristics of social interaction. In earlier work, Warner (1988) suggested that cyclical patterns of vocal behaviors such as amount of talking (or turn duration over time) may be synchronized with breathing cycles in some speakers. That is, patterns of "physiological rhythms" (as in breathing), will influence the likelihood of initiating and maintaining a behavior such as turn-taking and amount of talking in conversation.

The relevance of biological or physiological rhythm to stuttering can found in Anderson et al. (2003), who observed that CWS were more likely to exhibit irregular physiological functions as measured by the behavioral style questionnaire (McDevitt & Carey, 1987), and that such irregular patterns seem to be linked to temperament. It remains to be seen whether global biological rhythms manifest in the cyclicity of vocal interaction in children who stutter, or how such a relationship might be related to stuttering; however, taken together findings suggest that temperament may play a role not only in the development of CIT, but also in the rhythm of interaction over time, and that the presence of stuttering may interrupt cycles of predictable vocal behavior.

CONTINUING EDUCATION

Coordinated interpersonal timing in the conversations of children who stutter and their mothers and fathers

QUESTIONS

1. Coordinated Interpersonal Timing (CIT) refers to:
   a. the phenomenon of synchrony, or temporal coordination between co-conversationalists
   b. the difference between a child and parent in their speaking rate during conversation
   c. the relationship between stuttering severity and turn-switching pause duration in young children who stutter
   d. the extent to which physiological events associated with speaking (i.e., onset of respiration) are coordinated between speakers in a conversation
   e. the observation that the parents of children who stutter typically speak at the same rate as their children
2. Research in the temporal aspects of parent–child conversation has focused on the analysis of means of measures taken over the course of the entire interaction. A limitation of this analysis method is that:
   a. it is biased by group membership (i.e., stuttering vs nonstuttering children)
   b. it is difficult at best to operationally define the measures themselves
   c. there is little or no precedent for it
   d. it does not allow for examination of how the interaction unfolds over time
   e. there is no clinical applicability for the results obtained
3. Studies of Coordinated Interpersonal Timing (CIT) have shown that it can be found in parent–child interactions as early as
   a. preschool
   b. high school
   c. elementary school
   d. one year of age
   e. infancy
4. It is possible that a child's temperament may be related to the presence or degree of Coordinated Interpersonal Timing (CIT) he or she achieves during conversation. Specifically:
   a. children with aggressive temperaments may not achieve CIT in verbal interactions
   b. children who exhibit behaviors consistent with a heightened sensitivity to both internal and external (environmental) stimuli are more likely to achieve CIT, and may also show an increased degree of CIT when compared to other children
   c. children with low self-esteem are not likely to achieve CIT
   d. children with a tendency to be 'clingy' have a higher tendency to achieve CIT with their mothers, but not their fathers
   e. Shy or withdrawn children do not typically achieve CIT with their peers
5. Results from the present study suggest, among other things, that:
   a. operant based therapy approaches are not efficacious
   b. therapy focusing on rate reduction and increased turn-switching pause time is not efficacious

c. children who stutter who achieve pervasive (and perhaps stronger) CIT when talking with their parents, are good candidates for therapy that focuses on parent modification of the temporal aspects of speaking (i.e., rate reduction)
d. CIT is not valid in describing the nature of parent–stuttering child interaction
e. parents of children who stutter tend to speak faster than their children during conversations with them

References

Adams, M. (1990). The demands and capacities model I: Theoretical elaborations. *Journal of Fluency Disorders*, *15*, 135–141.

Anderson, J. D., Pellowski, M. W., Conture, E. G., & Kelly, E. M. (2003). Temperamental characteristics of young children who stutter. *Journal of Speech-Language and Hearing Research*, *46*, 1221–1233.

Andrews, G., Craig, A., Feyer, A.-M., Hoddinott, S., Howie, P., & Neilson, M. (1983). Stuttering: A review of research findings and theories circa 1982. *Journal of Speech and Hearing Disorders*, *48*, 226–246.

Andrews, G., Neilson, M., & Cassar, M. (1987). Informing students about treatment. In L. Rustin, H. Purser, & D. Rowley (Eds.), *Progress in the treatment of fluency disorders*. London: Taylor and Francis.

Beebe, B., Jaffe, J., Feldstein, S., Mays, K., & Alson, D. (1985). Interpersonal timing: The application of an adult dialogue model to mother–infant vocal and kinesic interactions. In T. M. Fields & N. A. Fox (Eds.), *Social perception in infants*. Norwood, NJ: Ablex Publishing Corporation.

Bernstein Ratner, N. (1992). Measurable outcomes of instructions to modify normal parent–child verbal interactions: Implications for indirect stuttering therapy. *Journal of Speech and Hearing Research*, *35*, 14–20.

Bland, J. M., & Altman, D. G. (1995). Statistics notes: Multiple significance tests: the Bonferroni method. *Biomedical Journal*, *3*, 170.

Bloodstein, O. (1975). Stuttering as tension and fragmentation. In J. Eisenson (Ed.), *Stuttering: A second symposium*. New York: Harper & Row.

Bloodstein, O. (1995). *A handbook on stuttering*. San Diego, CA: Singular Publishing Group, Inc..

Burgemeister, B. B., Blum, L. H., & Lorge, I. (1972). *Columbia Mental Maturity Scale – Revised*. Los Angeles: Western Psychological Corporation.

Cappella, J. (1981). Mutual influence in expressive behavior: Adult-adult and Infant-adult dyadic interaction. *Psychological Bulletin*, *89*(1), 101–132.

Cappella, J. N., & Greene, J. O. (1982). A discrepancy-arousal explanation of mutual influence in expressive behavior for adult and infant-adult interaction. *Communicative Monographs*, *19*, 89–114.

Cassotta, L., Feldstein, S., & Jaffe, J. (1964). AVTA: A device for automatic vocal transaction analysis. *Journal of the Experimental Analysis of Behavior*, *7*, 99–104.

Cassotta, L., Feldstein, S., & Jaffe, J. (1964). The stability and modifiability of individual vocal characteristics in stress and nonstress interviews. *Research bulletin No. 2*. New York: William Alanson White Institute.

Cattell, R. B., Cattell, A. K., & Cattell, H. E. P. (1993). *Sixteen personality factor questionnaire*. Savoy, IL: Institute for Personality and Ability Testing.

Chapple, E. D. (1970). *Culture and biological man*. New York: Holt, Rinehart & Winston.

Conture, E. G. (1990). *Stuttering* (2nd ed.). Englewood Cliffs, NJ: Prentice-Hall.

Conture, E. G. (2001). *Stuttering: its nature, diagnosis, and treatment*. Needham Heights, MA: Allyn & Bacon.

Cordes, A. (1994). The reliability of observational data: I. Theories and methods for speech-language pathology. *Journal of Speech, Language, and Hearing Research*, *37*, 264–278.

Cox, R. (2005). Evidence-based practice in provision of amplification. *Journal of the American Academy of Audiology*, *16*, 419–438.

Craig, H., & Gallagher, T. (1983). Adult-child discourse: The conversational relevance of pauses. *Journal of Pragmatics*, *7*, 347–360.

Crown, C. L. (1991). Coordinated interpersonal timing of vision and voice as a function of interpersonal attraction. *Journal of Language and Social Psychology*, *10*, pp. 92–46.

Egolf, D. B., Shames, G. H., Johnson, P. R., & Kasprisin-Burrelli, A. (1972). The use of parent–child interaction patterns in therapy for young stutterers. *Journal of Speech and Hearing Disorders*, *37*, 222–232.

Feldstein, S. (1972). Temporal patterns of dialogue: Basic research and reconsiderations. In A. W. Siegman & B. Pope (Eds.), *Studies in dyadic communication* (pp. 91–113). New York: Pergamon.

Feldstein, S. (1998). Some nonobvious consequences of monitoring time in conversation. In: M T. Spence, (Ed.), *Progress in communication science*.

Feldstein, S., BenDebba, M., & Alberti, L. (1974). Distributional characteristics of simultaneous speech in conversation. *Journal of the Acoustical Society of America*, *55*(Suppl.), S42 (Abstract).

Feldstein, S., Konstantareas, M., Oxman, J., & Webster, C. (1982). The chronography of interactions with autistic speakers: An initial report. *Journal of Communication Disorders*, *15*, 451–460.

Feldstein, S., & Welkowitz, J. (1987). A chronography of conversation: defense of an objective approach. In A. W. Siegman & S. Feldstein (Eds.), *Nonverbal behavior and communication* (pp. 329–378). Hillsdale, NJ: Lawrence Erlbaum Associates.

Franken, M. C., Kielstra-Van der Schalk, C., & Boelens, H. (2005). Experimental treatment of early stuttering: A preliminary study. *Journal of Fluency Disorders*, *30*, 189–199.

Garvey, C., & Berninger, G. (1981). Timing and turn-taking in children's conversations. *Discourse Processes*, *4*, 27–57.

Giles, H., Taylor, D. M., & Bourhis, R. Y. (1973). Towards a theory of interpersonal accommodation through language: Some Canadian data. *Language in Society*, *2*, 177–192.

Glasner, P., & Rosenthal, D. (1957). Parental diagnosis of stuttering in young children. *Journal of Speech and Hearing Disorders*, *22*, 288–295.

Gregory, H. (2003). *Stuttering therapy: Rationale and procedures*. Boston: Allyn & Bacon.

Guitar, B. (2006). *Stuttering: An integrated approach to its nature and treatment*. Philadelphia: Lippincott Williams & Wilkins.

Guitar, B., & Marchinkoski, L. (2001). Influence of mother's slower speech on their children's speech rate. *Journal of Speech and Hearing Research*, *4*, 853–861.

Hane, A., Feldstein, S., & Dernetz, V. (2003). The relation between coordinated interpersonal timing and maternal sensitivity in 4 month-old infants. *Journal of Psycholinguistic Research*, *32*(*5*.), 525–539.

Helmreich, R. L., Spence, J. T., & Wilhelm, J. A. (1981). A psychometric analysis of the personal attributes questionnaire. *Sex Roles*, *7*, 1097–1108.

Ingham, R. J. (2004). Clinicians deserve better: Observations on a clinical forum titled "What child language research may contribute to the understanding and treatment of stuttering". *Language, Speech and Hearing Services in the Schools*, *36*, 152–156.

Jaffe, J., & Feldstein, S. (1970). *Rhythms of dialogue*. New York: Academic Press.

Jaffe, J., Beebe, B., Feldstein, S., Crown, C., & Jasnow, M. (2001). Rhythms of dialogue in infancy: Coordinated timing in development. *Monographs of the Society for Research in Child Development*, *66*(2), 1–132.

Johnson, W., & Associates. (1959). *The onset of stuttering*. Minneapolis, MN: University of Minnesota Press.

Jasnow, M., Crown, C., Feldstein, S., Taylor, L., Beebe, B., & Jaffe, J. (1988). Coordinated interpersonal timing in mother and infants: Evidence for a buffered mechanism of social interaction. *Biological Bulletin*, *175*, 355–360.

Jasnow, M., & Feldstein, S. (1986). Adult-like temporal characteristics of mother–infant vocal interaction. *Child Development*, *57*, 754–761.

Kasprisin-Burrelli, A., Egolf, D. B., & Shames, G. H. (1972). A comparison of parental verbal behavior with stuttering and nonstuttering children. *Journal of Communication Disorders*, *5*, 335–346.

Kelly, E. M. (1994). Speech rates and turn-taking behaviors of children who stutter and their fathers. *Journal of Speech and Hearing Research*, *37*, 1267–1284.

Kelly, E. M., & Conture, E. G. (1992). Speaking rates, response time latencies, and interrupting behavior of young stutterers, nonstutterers, and their mothers. *Journal of Speech and Hearing Research*, *35*, 1256–1267.

Kent, R. D. (1981). Sensorimotor aspects of speech development. In R. D. Alberts & M. R. Peterson (Eds.), *The development of perception: Psycho-biological perspectives*. New York: Academic Press.

LaFrance, M. (1979). Nonverbal synchrony and rapport: Analysis by the cross-lag technique. *Social Psychology Quarterly*, *42*, 66–70.

Langlois, A., Hanrahan, L., & Inouye, L. (1986). A comparison of interactions between stuttering children, nonstuttering children, and their mothers. *Journal of Fluency Disorders*, *11*, 263–273.

LaSalle, L. (1999). Temperament in preschoolers who stutter: A preliminary investigation. Paper presented at the Annual Meeting of the American Speech-Language-Hearing Association, San Francisco, CA.

Logan, K. J., & Conture, E. G. (1997). Selected temporal, grammatical, and phonological characteristics of conversational utterances produced by children who stutter. *Journal of Speech, Language, and Hearing Research*, *40*, 107–120.

Main, M., & Solomon, J. (1986). Discovery of an insecure-disorganized/disoriented attachment pattern. In T. B. Brazelton & M. Yogman (Eds.), *Affective development in infancy* (pp. 95–124). Norwood, NJ: Ablex.

McDevitt, S. C., & Carey, W. B. (1987). The measure of temperament in 3–7-year-old children. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, *19*, 245–253.

Meyers, S. C., & Freeman, F. J. (1985a). Interruptions as a variable in stuttering and disfluency. *Journal of Speech and Hearing Research*, *28*, 428–435.

Meyers, S. C., & Freeman, F. J. (1985b). Mother and child speech rates as a variable in stuttering and disfluency. *Journal of Speech and Hearing Research*, *28*, 436–444.

Mordecai, D. (1979). An investigation of the communicative styles of mothers and fathers of stuttering versus nonstuttering preschool children. *Dissertation Abstracts International, 40*, 4759-B.

Onslow, M., Andrews, C., & Lincoln, M. (1994). A control/experimental trial of an operant treatment for early stuttering. *Journal of Speech and Hearing Research*, *37*, 1244–1259.

Oyler, M. E. (1996, November). *Temperament: Stuttering and the behaviorally inhibited child*. A paper presented at the annual convention of the American Speech-Language-Hearing Association. Seattle, WA.

Oyler, M. E. (1999, November). *Nature/nurture controversy: Temperamental sensitivity in children who stutter*. A paper presented at the annual convention of the American Speech-Language-Hearing Association. San Francisco, CA.

Pigott, T., Barry, J., Hughes, B., Eastin, D., Titus, P., Stensel, H., et al. (1985). *Speech-ease screening inventory (K-1)*. San Antonio, TX: Pro-ed.

Rustin, L., Botterill, W., & Kelman, E. (1996). *Assessment and therapy for young dysfluent children*. London: Whurr.

Smith, A., & Kelly, E. (1997). Stuttering: A dynamic, multifactorial model. In R. F. Curlee & G. M. Siegel (Eds.), *Nature and treatment of stuttering: New directions* (2nd ed., pp. 204–217). Needham Heights, MD: Allyn & Bacon.

Spence, J. T., & Helmreich, R. L. (1979). *Masculinity and femininity: Their psychological dimensions, correlates, and antecedents*. Austin: University of Texas Press.

Starkweather, C. W. (1997). Therapy for younger children. In R. F. Curlee & G. M. Siegel (Eds.), *Nature and treatment of stuttering: New directions* (2nd ed., pp. 257–279). Boston: Allyn and Bacon.

Starkweather, C. W., & Gottwald, S. R. (1990). The demands and capacities model II: Clinical application. *Journal of Fluency Disorders*, *15*, 143–157.

Stephenson-Opsal, D., & Bernstein Ratner, N. (1988). Maternal speech rate modification and childhood stuttering. *Journal of Fluency Disorders*, *13*, 49–56.

Warner, R. (1988). Rhythm in social interaction. In J. E. McGrath (Ed.), *The social psychology of time: New perspectives*. Beverly Hills, CA: Sage.

Warner, R. (1992a). Sequential analysis of social interaction: Assessing internal versus social determinants of behavior. *Journal of Personality and Social Psychology*, *63*, 51–60.

Warner, R. (1992b). Dimensions of social interaction tempo: A factor analytic study of time and frequency domain indexes of interaction structure. *Journal of Psycholinguistic Research*, *21*, 173–191.

Warner, R., & Mooney, K. (1988). Individual differences in vocal activity rhythm: Fourier analysis of cyclicity in amount of talk. *Journal of Psycholinguistic Research*, *17*, 99–111.

Webb, J. T. (1972). Interview synchrony: An investigation of two speech rate measures. In A. W. Siegman & B. Pope (Eds.), *Studies in dyadic communication* (pp. 115–133). New York: Pergamon Press.

Weiss, A. L., & Zebrowski, P. M. (1991, November). A *comparison of classroom discourse competencies of stuttering and nonstuttering students*. A paper presented at the American Speech-Language-Hearing Association, Atlanta, GA.

Welkowitz, J., Bond, R. N., Feldman, L., & Tota, M. E. (1990). Conversational time patterns and mutual influence in parent–child interactions: A time series approach. *Journal of Psycholinguistic Research*, *19*(*4*), 221–243.

Welkowitz, J., Cariffe, G., & Feldstein, S. (1976). Conversational congruence as a criterion of socialization in children. *Child Development*, *47*, 269–272.

Welkowitz, J. & Feldstein, S. (1969). Dyadic interaction and induced differences in perceived similarity. *Proceedings of the 77th Annual Convention of the American Psychological Association*, *4*, 343–344.

Welkowitz, J., & Feldstein, S. (1970). Relation of experimentally manipulated interpersonal perception and psychological differentiation to the temporal patterning of conversation. *Proceedings of the 78th Annual Convention of the American Psychological Association*, *5*, 387–388.

Welkowitz, J., & Kuc, M. (1973). Interrelationships among warmth, genuineness, empathy, and temporal speech patterns in interpersonal interaction. *Journal of Consulting and Clinical Psychology*, *41*, 472–473.

Wirt, R. D., Seat, P., & Broen, W. E. (1984). *Personality inventory for children*. Los Angeles, CA: Western Psychological Services.

Yairi, E., & Ambrose, N. G. (2005). *Early childhood stuttering*. Austin, TX: Pro-ed.

Yaruss, J. S., & Conture, E. G. (1992, November). *Relationship between mother and child speaking rates in adjacent fluent utterances*. Paper presented at the annual convention of the American Speech-Language-Hearing Association. San Antonio, TX.

Zebrowski, P. M. (1991). Preliminary acoustic analysis of the perceptually fluent speech and stuttering children before and after intensive therapy. In H. Peters, W. Hulstijn, & C. W. Starkweather (Eds.), *Speech motor control and stuttering*. Amsterdam: Elsevier Science Publishers.

Zebrowski, P. M., Conture, E., & Cudahy, E. A. (1985). Acoustic analysis of young stutterers' fluency: Preliminary observations. *Journal of Fluency Disorders*, *10*, 173–192.

Zebrowski, P. M., & Kelly, E. M. (2002). *Manual of stuttering intervention*. Clifton Park: Thomson-Delmar Learning.

Zebrowski, P. M., Weiss, A. L., Savelkoul, E. M., & Hammer, C. S. (1996). The effect of maternal rate reduction on the stuttering, speech rates, and linguistic productions of children who stutter: Evidence from individual dyads. *Clinical Linguistics and Phonetics*, *10*, 189–206.

Zimmerman, I. L., Steiner, V. G., & Pond, R. E. (1992). *Preschool language scale—3*. San Antonio: Harcourt, Brace & Company.

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