J Nonverbal Behav (2013) 37:281–305
DOI 10.1007/s10919-013-0158-9

ORIGINAL PAPER

Conversational Synchronization in Naturally Occurring Settings: A Recurrence-Based Analysis of Gaze Directions and Speech Rhythms of Staff and Clients with Intellectual Disability

Ellen Reuzel · Petri J. C. M. Embregts · Anna M. T. Bosman · Ralf Cox · Maroesjka van Nieuwenhuijzen · Andrew Jahoda

Published online: 15 August 2013

Abstract Past research has shown that rapport and cooperation between individuals is related to the level of nonverbal synchrony they achieve in their interactions. This study investigates the extent to which staff and clients with mild to borderline intellectual disability achieve interactional synchrony in daily social interactions. Whilst there has been work examining how staff can adapt their verbal communication to help achieve better mutual understanding, there has been an absence of work concerning the responsiveness of staff and

E. Reuzel · P. J. C. M. Embregts
Tilburg University, Tilburg, The Netherlands

E. Reuzel (✉)
J.P. van den Bentstichting, PO Box 361, 7400 AJ Deventer, The Netherlands
e-mail: ereuzel@jpvandenbent.nl

P. J. C. M. Embregts
HAN University of Applied Sciences, Nijmegen, The Netherlands

P. J. C. M. Embregts
Dichterbij Kennisn@, Ottersum, The Netherlands

A. M. T. Bosman
Behavioral Science Institute, Radboud University Nijmegen, Nijmegen, The Netherlands

R. Cox
Heymans Institute, University of Groningen, Groningen, The Netherlands

M. van Nieuwenhuijzen
Department of Clinical Child and Family Studies, VU University of Amsterdam, Amsterdam, The Netherlands

M. van Nieuwenhuijzen
The EMGO Institute for Health and Care Research, VU University of Amsterdam, Amsterdam, The Netherlands

A. Jahoda
University of Glasgow, Glasgow, UK

clients regarding their nonverbal behavior. Nineteen staff members video-recorded a social interaction with one of their clients in which the client had a need for support. The recordings were analyzed using cross recurrence quantification analysis. In addition, fifteen staff members as well as clients with an intellectual disability completed a questionnaire on the quality of the nineteen video-recorded interactions. Analysis of the nonverbal patterns of interaction showed that the staff–client dyads achieved interactional synchrony, but that this synchrony is not pervasive to all nonverbal behaviors. The client observers appeared to be more sensitive to this synchrony or to value it more highly than the staff raters. Staff observers were sensitive to quantitative measures of talking. The more staff in the interactions talked, the lower the quality rating of the interaction. The more the clients talked, the more positively the staff observers rated the interactions. These findings have implications for how collaborative relationships between clients and support workers should be understood.

Keywords Staff–client interactions · Collaborative relationship · Intellectual disabilities · Interactional patterns · Social interactions · Nonverbal communication

Introduction

'Interactions between staff and clients with an intellectual disability (ID) are crucial to how successful services are in meeting people's needs' (Social Exclusion Unit 2005, p. 57). Successful social interactions also contribute to the empowerment of clients with ID by encouraging them to play an active part in inter-personal encounters. Finlay et al. (2008, p. 350) state that: 'Empowerment is not just about choosing to take this type of support rather than that, but it is about what happens between people moment by moment, in the mundane details of everyday interaction'. A number of researchers have examined verbal interactions between staff and clients. For example, Antaki and Rapley (1996) and Antaki et al. (2002) found that staff tend to be controlling when interacting with people with an ID. Recent studies indicated that staff tend to favor the use of directives and questions and may fail to adjust their language to the client's level of understanding (Jingree et al. 2006). Hence, clients seem to be presented with few opportunities to engage as equal partners in conversational interchanges (Leudar 1981; McConkey et al. 1999).

In contrast to these findings, a recent study by Reuzel et al. (2012) found that interactions between staff and clients had a relatively balanced distribution of power, albeit each communicative partner tended to use different verbal strategies to influence the conversation. Staff asked more direct questions and sometimes neglected meaningful contributions from clients. Clients, on the other hand, provided more extended turns in response to staff members' questions, thereby helping to maintain the dialogue. However, in a notable minority of communicative turns, the clients failed to link with the staff member's contribution. This points to the difficulties staff and clients can face when trying to establish collaborative dialogues on shared topics. Despite the growing body of work in the field of verbal communication between staff and clients, there is a paucity of research concerning the underlying nonverbal dynamic processes that occur during communication. Therefore, the present paper will focus on the nature of nonverbal dynamical interactional patterns between staff and clients with IDs.

To improve communication, the onus has been on the staff member to adjust their verbal communication by using simpler language and to listen carefully to what the client is saying (Bartlett and Bunning 1997; Jahoda et al. 2009). Perhaps the reason why less

emphasis is placed on nonverbal behavioral patterns has been the assumption that even people with mild intellectual difficulties may have greater difficulty with socio-emotional understanding. Problems interpreting emotional cues have been suggested as reasons for higher levels of aggressive behavior displayed by individuals with ID (Zaja and Rojahn 2008). While people with autism have quite specific socio-emotional deficits, Moore (2001) made clear that this is not necessarily the case for people with intellectual disabilities. He pointed out that a drawback with research in this area is that it has often examined people's ability to label static emotional cues. However, the ability to synchronize inter-personal behavior when interacting with others relies on other tacit skills for dealing with dynamic social cues. This is, therefore, an area that warrants further investigation.

There have been striking insights into the brain's sensitivity to social information (for a review, see Cacioppo et al. 2006) and the way in which people think and act cooperatively (Hutchins 1995). An essential feature of this so-called joint action is how each person's nuanced actions shape the other's as the joint action unfolds. For example, when two people talk, they spontaneously converge in terms of pausing and speaking duration, speaking rate, turn duration, response latency, vocal intensity, and accent. Movements and postures, likewise appear to be spontaneously coordinated with speech within and across individuals (see Fowler et al. 2008 for a review). Interpersonal coordination is the degree in which the behaviors in an interaction are nonrandom, that is, patterned and synchronized in both time and form (Bernieri and Rosenthal 1991).

In this study, synchronization will be defined as the reciprocity of staff and clients' nonverbal behavior or in the coordination of taking turns. A variety of theoretical frameworks predict the resemblance of behaviors between two people engaged in communication, in the form of coordination, mimicry, or alignment. For example, there is evidence that people coordinate their behavior when they collaborate to solve problems with mutually understood structure (Sebanz et al. 2006). However, little is known about the time course of the behavior matching (Louwerse et al. 2012). Therefore, this study examines the temporal relationship between two specific nonverbal matching behaviors of the communicative partners, namely gaze direction and speech rhythm. These behaviors are key elements of dialogue (Goodwin 1981; McNeill 1992; Sacks 1992). The alignment of speech rhythms and gaze patterns have been examined by a number of researchers (Cappella and Planalp 1981; de Graag et al. 2012; Giles et al. 1991; Louwerse et al. 2012; Richardson et al. 2007; Street 1984) and are found to be associated with the quality of the interactions. We chose speech rhythm and gaze direction as behavioral variables, because they enabled us to assess the behavior of multiple dyads in a similar way. As far as we known, no information is available on the level of synchronization of nonverbal behavior that occurs within the specific context of daily social interactions between staff and clients with mild to borderline ID.

Investigating the underlying dynamics that occur during the mutual exchange of information provides important insights into the nature of the interaction. For example, the coordination of turn taking requires cooperation between staff and clients at a nonverbal level, in terms of taking initiatives and being responsive to each other. Chapple (1970) found that during interaction partners signal their readiness to act, and the patterns observed between interactants represent the compromises they reach, which we refer to as synchrony. It has also been demonstrated that the cyclicity of vocal activity increases over the course of face-to-face dialogues (Warner 1992). This means that, as the conversation progresses, interactants search to find a rhythm that allows them to take turns holding the floor while still following their own tendency to be talkative. Optimally, interactants reach

a point at which their tendencies to be talkative alternate, resulting in fewer interruptions and silent pauses. Conversational precision is thus a function of the phase relation between each speaker's vocal activity rhythms. Other studies found that the eye movements of two interactants are coupled and that this coupling reflects the quality of the interaction (de Graag et al. 2012; Richardson et al. 2007). In addition, eye movements were found to embody the cognitive processing involved in cooperative conversation and the shared knowledge among interlocutors (Shockley et al. 2009).

More recent studies stressed the theoretical significance of the manner and extent to which people synchronize behavior matching during social interaction (Schmidt et al. 2012). Louwerse et al. (2012) found that synchronization is pervasive and uniform within multiple modality groups and this synchronization is sensitive to social and task variables. Hove and Risen (2009) stressed the relationship between synchronization and social affiliation, with each enhancing the other. Rapport building, the smoothness of a social encounter, and cooperation efficiency are closely linked to the ability to synchronize with a partner (Delaherche et al. 2012). For interactions to be successful, rapport or engagement appears to be of crucial importance. Rapport is a phenomenon that emerges during the interaction between individuals; it is not a personality trait, albeit some people may be better at inducing rapport than others. It refers to a situation in which people have similar feelings and experience positive interactions. According to Tickle-Degnen and Rosenthal (1990), rapport consists of three components: mutual attention, mutual positivity (friendliness and caring), and coordination. Behavioral coordination becomes particularly important when interactants learn to know each other. Behavioral coordination is visible when people mirror one another in posture or when they are in interactional synchrony (e.g., Chartrand and Bargh 1999). Miles et al. (2009) found a direct link between levels of rapport and interpersonal coordination, that is, high levels of rapport were associated with stable coordinative interaction patterns.

In this study, a nonlinear time-series analysis technique called recurrence analysis was used to examine the nonverbal patterns of synchronization of staff and client dyads (e.g., Church 1993; Eckmann et al. 1987; Marwan et al. 2007; Von Heijne 1987; Zbilut and Webber 1992; see Dale and Spivey 2005, for a review, and Webber and Zbilut 2005, for an excellent technical introduction). This technique was originally used for the analysis of time series of continuous variables of physical or biological systems. Recently, however, the technique has been successfully applied in the social and behavioral sciences and used to explore patterns of syntactic coordination between children and parents (Dale and Spivey 2006), eye movement synchronization between speakers and listeners (Richardson et al. 2007), mother-infant gaze flexibility during reunion in a still-face procedure (de Graag et al. 2011), and intervention-induced changes in parent–child conflict conversations (Lichtwarck-Aschoff et al. 2012). This method provides an analysis of global structural patterns of dialogue, charting how gaze direction and temporal speech patterns of staff and clients align during interaction. By global we mean drawing general quantitative measures with minimal dependence on statistical assumptions, describing the extent to which a series of staff–client interactions involves gaze direction and temporal speech structures that are more or less attuned to each other. The aim is to quantify the extent to which nonverbal behavior is coordinated in naturalistic dialogue (Dale and Spivey 2006). Because knowledge with respect to synchronization of gaze direction and speech rhythms is scarce, especially within the context of natural face to face dialogues, we did not know what to expect. We assumed that high levels of speech synchronization and gaze directions are related to higher levels of rapport, based on earlier findings in the literature.

We formulated the goal of the current paper in terms of three specific questions concerning nonverbal behavior between staff and clients with ID:

1. What level of attunement and synchronization (i.e., coordination) is achieved in terms of their gaze directions and speech rhythms?
2. What is the pattern of dominance in the dialogue with respect to interlocutors initiating nonverbal behaviors such as gaze direction or following the other's lead?
3. Are key elements of staff and clients' coded nonverbal behavior (levels of attunement and dominance) associated with observer ratings of the quality of the interactions?

Method

Participants

Staff

Nineteen staff members (3 men and 16 women), working at the JP van den Bent foundation in the Netherlands, participated in this study. This is a foundation that provides services to people with an ID. The role of staff is to support clients with a broad spectrum of daily living tasks, such as helping with household jobs, planning social and vocational activities, arranging appointments, healthcare, and relationship difficulties. Staff members discuss their input with clients and agree on a support action plan, which sets out the nature of support to be given and how it will be provided. The staff members worked in different regions and work settings. Most staff members ($n = 13$) worked in community-based residential houses, three worked in outreach care for people living in their own homes, and three worked in crisis care, which is care for people who need immediate housing and care due to different causes, for example a mental breakdown. Their mean experience of working in services for people with ID was 7.1 years (*Range* = 1–27 years).

Clients

Each staff member was asked to select a client with whom they worked frequently, or who they meet with at least once a week. Clients' chronological ages ranged from 18 to 39 years ($M = 25.1$ years; $SD = 6.1$). Seven of the clients were men and twelve were women, and they all lived in community care settings and received support from services; three clients lived alone in their own apartment with outreach care, and seven lived alone or with a partner with 24 h support available; six clients lived in staffed houses for training purposes, and three clients lived in staffed houses temporarily (crisis care). The Wechsler Adult Intelligence Scale (WAIS-3) was used to assess their level of cognitive functioning. Their scores ranged from mild (8) to borderline intellectual functioning (11). Mild intellectual functioning means having an Intelligent Quotient between 50 and 70, and borderline intellectual functioning means having an IQ between 70 and 85. All clients had sufficient verbal ability to express their thoughts and feelings.

Observer Raters

Fourteen staff members and 14 clients with ID observed the 19 interactions on video. Staff and clients worked or lived in crisis care and did not know the staff and clients shown on

the video recordings. The mean age of staff was 32.4 years and ranged from 20 to 52 years. Eleven staff members were women and three were men. Clients' ages ranged from 18 to 59 years ($M = 26.9$ years). Six of the clients were men and eight were women. Their WAIS scores ranged from mild (6) to borderline intellectual functioning (8). All clients had good expressive and receptive verbal skills.

Procedure

After obtaining permission from the organization to conduct the research, managers and psychologists were provided with information about the purpose of the study. Staff and clients who volunteered for the study received an explanation of its purpose and what was involved in participating. Staff and clients were informed orally and in writing; informed consent was obtained.

Participating staff video-recorded a regular conversation, which had already been scheduled, with a client in his or her home. They were asked to place the portable camcorder unobtrusively in a corner of the room, and to keep the situation as normal as possible. The interactions were required to meet the following criteria: (1) the interaction was related to the client's support plan, (2) the topic concerned an aspect of the participants' support needs, and (3) these particular interactions occurred on a regular basis, at least once a week. The average length of the video recordings was 14.6 min ($SD = 6.2$, $Range = 7.2$–29.7 min). No instructions were given to the participants other than to interact as usual. Ten different types of topics were discussed: (1) establishing or refining a support action plan ($n = 5$), (2) planning or evaluating client goals ($n = 1$), (3) planning household activities ($n = 4$), (4) planning other activities like making a weekly schedule or arranging a visit to the doctor ($n = 3$), (5) finding suitable leisure opportunities ($n = 2$), (6) planning finances ($n = 5$), (7) evaluating their work situation ($n = 2$), (8) discussing problems related to child care ($n = 1$), (9) coping with (conflicts with) other persons ($n = 6$) and (10) finding solutions for problems the clients faced ($n = 3$). All the topics of conversation required the clients and staff to listen actively to each other, in order to reach a shared view about how to tackle the issue being discussed.

Data Preparation

All videotapes were then transferred to 'The Observer XT'. The Observer XT is a professional event-logging software for the collection, analysis, and presentation of observational data and was developed by Noldus (2009). Next, nonverbal behavior was coded for staff and clients, namely the gaze direction (is the staff member or the client looking at the other person or is he/she looking elsewhere?) and speech rhythm (is the staff member or client talking or is he/she silent?). In order to prepare the data for analysis, four continuously-scored sequences of nonverbal behaviors were created for each dyad. Specifically, there were two time series' for gaze direction and two for speech rhythm, showing the client's and staff's looking and talking behavior over time. Each time series represented a dichotomous variable. That is, a score of 'one' representing staff or client looking at the other or talking, and the score 'zero' representing staff or client looking elsewhere or being silent. The raw time series was sampled with a sampling rate of 1 Hz. Choosing a sample rate that is too high will either amplify the effects of noise or inflate the influence of relatively stable periods. A sample rate that is too low will result in underdetermination of the relevant aspects of the behavior (particularly turn-taking in this study). The 1-Hz sample rate chosen here was considered to reveal the relevant dynamics

Time Code	...	t-4	t-3	t-2	t-1	t	t+1	t+2	t+3	t+4	...
Staff	...	0	0	1	1	1	1	1	1	0	...
Client	...	1	1	1	1	0	0	0	0	1	...

Fig. 1 Example of time series

of the conversation, since preliminary analysis established that the average turn durations of both interlocutors was longer than one second. So, finally, the four time series each had a single value at every interval of one second. Figure 1 presents an example of a time series of both staff member's and client's (1-Hz sampled dichotomized) nonverbal behavior.

These four time series' were analyzed with traditional linear analyses (distributions, *t* tests, and correlations) and a nonlinear analysis, namely, recurrence quantification analysis (RQA) (cross recurrence based; CRQA). The CRQA will be explained below. To assess inter-observer reliability initial coding was carried out with four videotapes, encompassing 53.2 min in which the gaze direction and talk/silence sequences of staff and clients were continuously coded. Inter-observer reliability was computed allowing a 0.5 s overlap. Since the video recordings were home-made and therefore the quality was variable, the recordings were displayed in slow motion in order to access an optimal accuracy on the moments where persons started or stopped talking or looked at the other or looked away. There was an overall agreement of 76 % for gaze direction and 81 % of the talk/silence sequences.

Next, fourteen staff members and fourteen clients observed the nineteen video-recorded interactions. After each video fragment they completed a short questionnaire derived from the Session Rating Scale (SRS) for staff and the Mentally Disabled Session Rating Scale (MSRS) for clients from Duncan et al. (2004), resulting in four items to evaluate each dyad:

- *The relation*: Did staff listen to the client?
- *Goals and subject*: Did the client want to talk about the items that were discussed?
- *Method*: Was the way staff discussed the items adequate?
- *Overall*: What was the overall impression of the interaction?

The questionnaire for clients was adjusted in consultation with four clients who did not participate in the observations. The language was changed to make the questions more accessible. After each question, the observer placed a dot on a 10 cm long line; the further they placed the dot to the right, the more positively the item was evaluated. For clients, visual means of support were added in the form of emoticons: A happy face was placed on the right side of the line and a sad face was placed on the left side of the line. Before staff and clients started the observations proper they practiced using the questionnaire with two example video fragments that were not included in the study. The researcher explained the items and made sure all observers understood what was being asked of them. The researcher had not met any of the observers prior to the research. The questionnaires were filled in anonymously and in silence, with no obtrusion from the researcher.

Data Analysis

In this section two types of analysis will be presented: the traditional linear analysis and the RQA.

Traditional Linear Analysis

This type of analysis offers a global overview of the amount and distribution of talking and looking of both staff and clients during the conversation. That is, this analysis will provide central tendency measures of the behavior of the interaction patterns. The frequencies of the different behaviors (gaze direction and talk and silence sequences) for each time series, the percentage of synchrony (%Sync), and correlations between these measures will be presented. Percentage synchrony is defined as the amount of time that the interacting partners spend looking at each other, or when one is talking while the other remains silent, as a percentage of the total duration of the interaction.

Recurrence Quantification Analysis

Recurrence quantification analysis is used to assess how coordinated the nonverbal behavior of the staff and clients is as the interaction unfolds. RQA is relative unknown within the field of social science and an extensive description is provided below. RQA is a particular type of nonlinear time-series analysis based on the registration of whether a system's state at each and every point during an observation recurs, that is, repeatedly occurs (e.g., Marwan et al. 2007; Webber and Zbilut 2005; Zbilut and Webber 1992). From these basic recurrences, several measures can be derived that quantify the dynamic organization of the underlying system. In order to study two interacting systems, cross-recurrence quantification analysis (CRQA) is performed (e.g., Shockley et al. 2002). In CRQA, recurrence reflects that the behavioral state of one of the systems (in this study the behavior of one interlocutor) also occurs in the other system (i.e., the other interlocutor) at some point in the time series either earlier, concurrently, or later. In the present study CRQA allows us to analyze attunement, synchrony, and dominance of staff's and client's gaze behavior and speech rhythm from the temporal pattern in the time series. The main research questions to which this analysis was applied were: (1) What level of attunement and synchronization (i.e., coordination) is achieved in terms of their gaze directions and speech rhythms? (2) What is the pattern of dominance in the dialogue in relation to interlocutors initiating nonverbal behaviors such as gaze direction or following the other's lead? (3) Are key elements of staff and clients' coded nonverbal behavior (levels of attunement and dominance) associated with observer ratings of the quality of the interactions? In terms of recurrence analysis these questions translate to the quantification of recurrence (i.e., counting recurrent points), particularly on and around the line of synchrony in the recurrence plot, as will be explained below. For an excellent in-depth treatise of CRQA in the context of conversation research, similar to the analysis performed here, we refer to the paper by Dale and Spivey (2006).

To answer the research questions stated above, categorical CRQA was performed on both the gaze-direction and the speech-rhythm time series of client and staff. This means that matches between nonverbal behaviors of all instances in the client's time series and all instances in the staff's time series are registered. These matches can graphically be represented in a two-dimensional grid, the rows of which represent the nonverbal behaviors of talking or looking of one of the interlocutors and the columns represent those of the other interlocutor. In each cell of this grid we place a 'black dot' when the cell reflects a recurrence (i.e., matching nonverbal behavior) or 'white dot' when there is no recurrence (i.e., non-matching nonverbal behavior).

In this study we have chosen the following operationalization of 'recurrence': With respect to gaze direction a black dot reflected the combination of both staff and client

looking at each other, whereas a white dot reflected all other combinations (i.e., one or both looking elsewhere). With respect to speech rhythm a black dot reflects an instance where only one of the interlocutors was talking, and a white dot reflects an instance where both were talking or both were silent. The reason for this particular arrangement of matching of client's and staff member's nonverbal behaviors is that it offers a meaningful partitioning of the interaction, as will become clear. The resulting graph is a cross recurrence plot (CRP) of two time series (Fig. 2). With the black-and-white coloring the CRP visualizes the periods where matching nonverbal behaviors are occurring and where behaviors are non-matching during the conversation.

An important set of points in the CRP is the main diagonal from the left-bottom corner to the right-top corner (diagonal line in Fig. 2). This diagonal, called the line-of-synchrony (LOS), reflects simultaneous recurrences, in our case, matches between client's and staff's nonverbal behavior performed at the same point in time. That is, where they stared face-to-face and (probably) made eye contact or where one was talking while the other was silent and (probably) was listening. The number of recurrent points (i.e., black dots) on the LOS divided by the total number of points of the line (which equals the length of the time series) is equivalent to the percentage of synchrony (%Sync).

The correspondence between the LOS and the central-tendency measure %Sync nicely demonstrates the fact that the CRP contains much more information than merely an analysis of matching actions at the same time. It offers a much broader quantification of the temporal pattern of nonverbal behavior on all timescales during the conversation. We can inspect the relative number and distribution of matching and non-matching looking or talking behaviors as the client–staff interaction unfolds over time. In fact, RQA is the

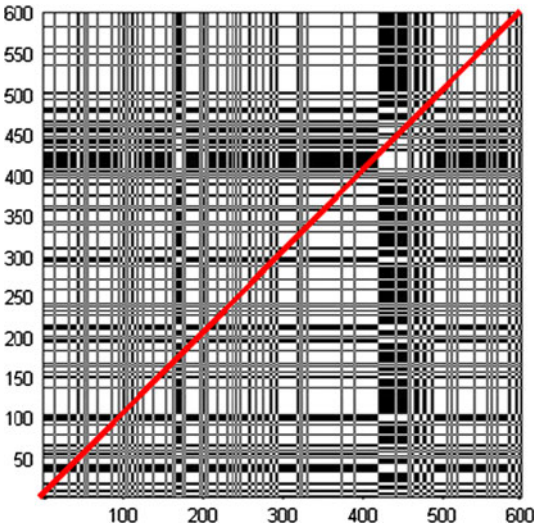

Fig. 2 Example cross recurrence plot. *Black* areas represent periods of one person talking matched by the other person being silent some time later or earlier, with respect to speech, or periods of one person looking at the other matched by the other looking back some time earlier or later, with respect to gaze. The *white* areas, on the other hand, represent periods of silence or talking of one matched before or after by silence or talking of the other (speech) or looking at the other that is not matched as well as both looking away (gaze). In this way the RP represents a raw structure that can capture the distributions of matching and non-matching non-verbal behaviour, together with when these are occurring in the conversations. The *diagonal line* is the line-of-synchrony (LOS; see text)

technique of extracting quantitative measures from CRPs (Zbilut and Webber 1992). All these derived measures are based on the basic concept of a recurrent point, as explained above in the context of the present study. The most basic measure drawn from a CRP is the *global recurrence rate* (RR_{global}), being the proportion of black dots (i.e., recurrent points) in the CRP. For the entire CRP this crude measure represents the overall extent to which staff and clients are using matching nonverbal behaviors. In the following we will introduce several other measures based on the recurrence rate in a predefined area of the CRP, specifically located around the LOS.

Important issues discussed in the introduction with regard to nonverbal coordination are interlocutors' asymmetry and dominance during conversation. In order to quantify these aspects, a number of other recurrence-based quantities can be obtained by calculating the extent to which matching nonverbal behaviors occur in temporal proximity, rather than exactly at the same time (as with %Sync) or across the entire length of the sample (as with RR_{global}). Stated differently, it assesses whether and how much staff and client tend to match their nonverbal behaviors *around* the same time in the conversation. In other words, CRQA is the technique used to investigate the dynamic nature of interactional synchrony and the phases of coordinated gaze patterns and speech rhythms. Regular face-to-face conversations will most likely show more prominent matching of nonverbal behaviors within a (small) interval around the 'presence'. As a result, recurrence will be higher within some area or temporal band around the line of synchrony than at larger distances in the CRP. This can be quantified by focusing on the relative number of black dots around the LOS. This measures has been labeled the *diagonal recurrence rate* of width *w* ($RR_{diag,w}$; see Dale and Spivey 2006), and is defined as the sum of black dots in the band of width w around the LOS, divided by the total number of dots (black plus white) in that particular area.

Of particular interest are the $RR_{diagline}$ of individual diagonal lines in the CRP, parallel to the LOS either (closely) above or below that line. In this study each single-step diagonal displacement of such a line away from the LOS represents a temporal shift of one second. This temporal shifting enables a direct comparison of the nonverbal behavior of one of the interlocutors to that of the other interlocutor one or more seconds earlier or later in the conversation. The size of the shift specifies how temporally distant (i.e., how much earlier or later) in the conversation the behaviors occurred, and its directions determines which of the interlocutors is initiating a particular nonverbal behavior. Specifically, when the client's nonverbal behavior time series is represented along the horizontal axis of the CRP and that of the staff along the vertical axis (see Fig. 2), the lower-right triangular area (below the LOS) holds the points where staff performs a particular behavior first, whereas the upper-left triangular area (above the LOS) those where the client was first. As can be seen from inspection of the CRP, the black dots in these areas reflect that such behavioral initiatives of one were matched some time later by the other. The further away these dots are from the LOS the later this matching occurred. For instance for speech rhythm, the parallel diagonal line directly above the LOS holds all the black dots that reflect either talking or silence by the client that is matched exactly one second later by the staff member's silence or talking, respectively. This means that the $RR_{diagline}$ of this line quantifies the amount of recurrence with a 1-s delay.

Let us consider a collection of such individual diagonal lines, each with a successive 1-s parallel shift away from the LOS, 20 steps below and 20 steps above the LOS (i.e., $w = 20$), and calculate $RR_{diagline}$ for each of them. In Fig. 3, these 40 individual single-line $RR_{diagline}$ values are aligned and drawn, together with the $RR_{diagline}$ of the LOS at '0' shift (which equals %Sync). This produces a so-called LOS-profile, which graphically represents the pattern of speech and gaze coordination.

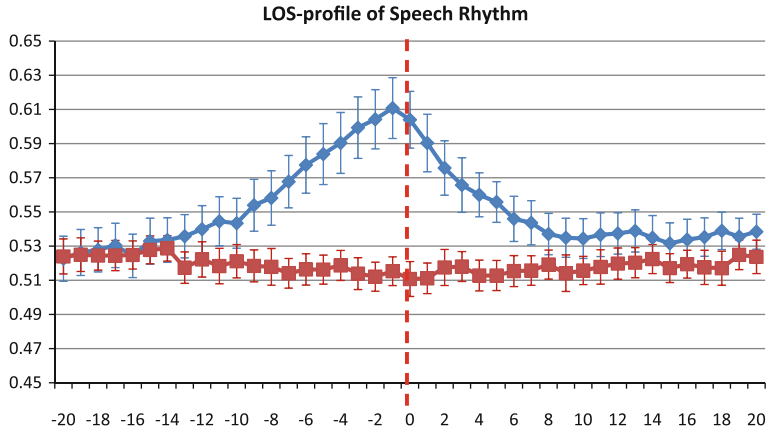

Fig. 3 Example of the results of a LOS-profile analysis for speech synchrony. The *curve above* (*diamonds*) shows the real-life conversation, whereas the *curve below* (*squares*) is the result of the LOS-profile analysis with shuffled time series. That is, with the temporal structure of the time series destroyed by the random re-distribution of the data points. The *error bars* reflect the standard errors of the mean for all conversations within each *diagonal line*

From the LOS-profile, several interesting measures can be derived. First of all, as can be seen in Fig. 3, the LOS-profile of a real-life conversation generally has a peak where the $RR_{diagline}$ obtains a maximal value, at some temporal shift around or on the LOS. This maximal value is labeled RR_{peak}, and provides a crude measure for the level of coordination between the two interlocutors. Secondly, the shift where this RR_{peak} is obtained is called τ_{peak}, and tells us about the delay in optimal matching between the interlocutors. Thirdly, the ratio between the total relative amount of recurrence in the LOS-profile on both sides of the LOS (i.e., the sum of RR_{diag}, which equals the area under the curve, left and right from 0 in Fig. 3) is a sign of how strongly one of the interlocutors is dominating the conversation.

In order to answer the research questions, we will make use of the measures the global recurrence rate, the percentage of synchrony, and the RR peak to determine the degree of coordination between staff and clients. The degree of initiating or following the nonverbal behavior patterns by staff or clients will be determined by the τ_{peak}, and the difference between the total relative amounts of recurrence in the LOS-profile on both sides of the LOS. These measures will be correlated with the observed quality of the interactions. For an overview of the used CRQA measures see Table 1.

Results

In this section we will answer the three research questions by using the CRQA measures described above. Prior to that the central-tendency measures and the observer ratings and the associations between the observer ratings and the central tendency measures will be presented. These data will be presented first in order to compare or associate them with CRQA measures.

Central-Tendency Measures, Observer ratings, and Their Associations

Table 2 shows the descriptive statistics of the time series gaze direction and speech rhythm for staff and clients.

Table 1 Recurrence-based measures and their description

Measure	Description
RR	Recurrence rate, the proportion of recurrent (i.e. matching) points in the recurrence plot For speech, *matching* was defined as one person talking while the other was silent; for gaze, it was defined as staring face-to-face
%Sync	Percentage-of-synchrony, the percentage of recurrent (i.e. matching) points on the Line-of-Synchrony (containing all matches and non-matches of non-verbal behaviours of client and staff performed at the same time) This measure equals the time interlocutors spend looking at each other, or turn-taking in speech divided by the total duration of the interaction
RR_{peak}	RR_{peak} is the maximum recurrence value in the LOS-profile For speech, this measure reflects the optimal point of interlocutors' tendency to be talkatively alternating
RR_{reldif}	RR_{reldif} is the maximum recurrence value in the LOS-profile relative to the 'background' (i.e. shuffled) recurrence value in the LOS-profile
τ_{peak}	τ_{peak} is the temporal difference in seconds between the point where RR_{peak} is reached and the line-of-synchrony (=zero shift) This measure reflects the delay in optimal matching between interlocutors and informs about the response time of one interlocutor to the other

Table 2 Mean (in percentages), SD, and range for the time series of gaze direction and speech rhythm for staff and clients

Dyads interactions	*Mean*	*SD*	*Range*
Client talks, irrespective whether staff talks or not	44.2	14.2	20.2–66.6
Staff talks, irrespective whether the client talks or not	48.3	12.3	28–67.2
Staff and client both talk at the same time	15.7	5.3	8.8–26
Staff and client are silent at the same time	23.2	9.5	8.2–46.6
Staff or client talks, while the other is silent (% synchrony)	60.4	7.24	41.8–70.1
Client looks at staff irrespective of staff's gaze direction	48.6	19.5	16.6–82.4
Client looks at staff, while staff looks elsewhere	12.1	5.2	4.3–20.9
Staff looks at client, irrespective of the client's gaze direction	66.2	16.8	24.8–89.2
Staff looks at client while client looks elsewhere	30.1	13.7	13.4–54.3
Staff and client both look elsewhere	20.6	16.1	3.2–60.9
Staff and client look at each other (% synchrony)	36.58	17.06	7.2–70.2

Paired samples t tests showed a non-significant difference between the time clients and staff talked, $t(18) = 0.80, p = 0.44$). Staff, however, looked significantly more often at the client than vice versa, $t(18) = 4.25$, $p = 0.001$) The analyses on the central-tendency measures revealed significant differences between the interlocutors individually. For example, some staff and clients seemed more talkative than others. There were also significant differences between the interactional patterns pertaining to nonverbal behaviors. With respect to gaze direction, it appeared that in one interaction the two speakers looked at each other for about 70 % of the time and in another interaction client and staff looked away from each other in 60 % of the time. With respect to the speech rhythm, in one interaction almost 47 % of the time there was total silence, whereas in another interaction staff and client talked at the same time in 26 % of the time. This suggests that each

interaction has its own nonverbal behavioral pattern. The observer ratings by staff and clients are described in Table 3.

In order to find out whether staff and clients observer ratings are comparable we correlated their scores. Table 3 shows high correlations between the observed scores of staff and clients, with exception of the way staff discuss the items. These results indicate that staff and client observers have a tendency to evaluate the quality of the interactions between dyads in a similar way.

Table 3 shows that client observers were generally more positive in their evaluations of the interactions than staff. The difference between scores of staff observers and client observers was significant for the degree staff listen to clients, the way staff discuss the items, and the overall impression. Staff observers and client observers were most satisfied with the way staff listen to clients.

Next, the associations between the observer ratings and the central-tendency measures are presented in Table 4.

In general, Table 4 shows that staff do not appear to base their judgments of the quality of the interactions on the central-tendency measures of the gaze directions. Instead, staff's judgments about the quality of the interactions are associated with measures of speaking or remaining silent. Staff observers believe that when staff are talking more, clients are less willing to talk about the subjects being discussed. They also believe that when staff talk more they have a tendency to listen less to clients. Noticeable is the fact that no associations were found between the observer ratings of clients and the results of the central-tendency measures for speech rhythms. This suggests that clients were not sensitive to quantitative measures of talking and remaining silent. Table 4 also shows that clients were relatively more sensitive to quantitative measures of gaze direction than staff. The results of the associations between observer ratings and central-tendency measures indicate that

Table 3 Observer's mean scores (min = 0. max = 10), SD, range of staff–client interactions and associations between staff scores and client scores

Question	Clients	Staff	*t* value	*p* value	*r* value	*p* value
Did staff listen to the client?						
M	7.9	6.9	3.3	0.004	0.54	0.02
SD	0.8	1.6				
Range	6.2–8.9	3–8.9				
Did the client want to talk about the items that were discussed?						
M	7.5	6.9	1.9	0.071	0.62	0.01
SD	1.4	1.5				
Range	2.5–8.8	2.5–9.0				
Was the way staff discussed the items adequate?						
M	7.6	6.1	4.3	0.001	0.32	0.18
SD	0.86	1.5				
Range	6–9.1	2.9–8.2				
Overall impression						
M	7.3	6	4	0.001	0.42	0.07
SD	1.2	1.5				
Range	3.8–8.9	3.2–8.2				

Table 4 Pearson correlations between the observer ratings by staff and clients and the central tendency measures on speech rhythm and gaze direction

	Both look at each other	Staff and client look elsewhere	Staff looks, client not	Client looks, staff not	Staff looks irrespective of the gaze direction of client	Client looks irrespective of the gaze direction staff	Staff and client talk	Staff and client are still	Staff talks, client is silent	Client talks, staff is silent	Staff talks irrespective of the client talking or not	Client talks, irrespective of the staff talking or not
Relation observed by clients	0.48*	−0.53*	−0.02	0.12	0.48*	0.46	0.14	−0.28	0.05	0.11	0.11	0.15
Goal observed by clients	0.45	−0.31	−0.32	0.29	0.2	0.48*	0.19	−0.35	−0.24	0.43	−0.15	0.43
Method observed by clients	0.49*	−0.61**	0.07	0.11	0.56*	0.47*	0.16	−0.36	0.13	0.09	0.19	0.13
Overall impression observed by clients	0.48*	−0.41	−0.29	0.34	0.27	0.53*	0.09	−0.29	0.02	0.17	0.06	0.175
Relation observed by staff	0.16	−0.12	−0.02	0.11	0.15	0.14	0.15	0.03	−0.5*	0.41	−0.42	0.4
Goal observed by staff	0.15	0.02	−0.3	0.36	−0.09	0.2	0.09	0.02	−0.54*	0.48*	−0.48*	0.44
Method observed by staff	0.04	−0.08	0.14	0.0	0.15	−0.01	0.16	0.06	−0.43	0.3	−0.34	0.32
Overall impression observed by staff	0.11	−0.08	0.02	0.07	0.13	0.08	0.11	0.11	−0.36	0.22	−0.29	0.23

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

Table 5 Mean scores in %, SD, and range for the CRQA measures of the staff–client interactions

CRQA measure	*Mean*	*SD*	*Range*
Gaze direction			
Global recurrence rate	32	19	04–69
Line of synchrony (LOS)	07	17	07–52
Speech rhythms			
Global recurrence rate	51	04	43–58
Line of synchrony	60	07	42–70
Recurrence rate peak or RR_{Peak}	67	04	58–74
τ_{peak} in seconds	−3.38	5.44	−19 to 3
Recurrence rate around the line of synchrony (LOS)	55	05	40–62
Difference between total relative amount of recurrence in the LOS-profile on both sides of the LOS	0.83	3.6	−6.9 to 7.6

clients and staff were sensitive to different aspects of nonverbal behavior. Clients were more sensitive to making eye contact, whereas staff were slightly more sensitive to the amount staff and clients talk. These findings will be compared to the results based on the CRQA, described next.

As discussed earlier, CRQA can reveal underlying dynamical patterns not visible in central-tendency measures. Table 5 presents *Mean* scores, *SD*s and Ranges for the CRQA measures of the staff–client interactions. As for the gaze direction, the only significant measures were the RR_{global} and the % of Synchrony. This means that with respect to the gaze direction no optimal attunement (or peak) was found and therefore these data are missing. In the following part we will explain what these results mean in terms of our research questions on coordination and initiating/leading or following nonverbal behavior patterns.

Next, we will present the results of the three research questions.

(1) What Kind of Attunement and Synchronization (i.e. Coordination) Occurs Between Staff and Clients in Their Gaze Directions and Speech Rhythms?

As described in the analysis section, a crude measure for coordination is (1) the global recurrence rate, which represents the overall extent to which staff and clients are using matching nonverbal behaviors, and (2) the percentage of synchrony, which represents the overall extent to which matching behaviors occur exactly at the same time. The average percentage that staff and client look at each other is 37 %, but the ranges show that there is a huge variety among the interactions. In some interactions people look at each other only 7 % of the time and in another interaction 70 % of the time. Because the analysis was based on four options for gaze direction, (i.e., staff looks at client, client looks at staff, both look at each other, both look elsewhere) statistically there is a 25 % chance that communicative partners look at each other. As a paired samples *t* test shows, 37 % is significantly larger than 25 % (t (18) = 2.9, p = 0.01) and therefore it is plausible to conclude that gaze directions are synchronized. However, based on the central tendencies (Table 2), we see that on average staff look at clients 66.2 % of the time and clients look at staff at

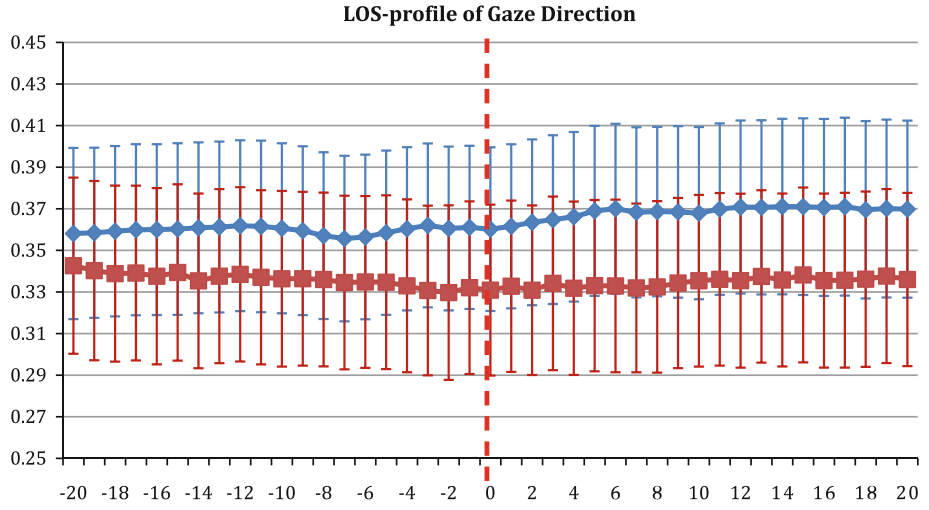

Fig. 4 Example of the results of a LOS-profile analysis for gaze direction. The *curve above* (*diamonds*) shows the real-life conversation, whereas the *curve below* (*squares*) is the result of the LOS-profile analysis with shuffled time series. That is, with the temporal structure of the time series destroyed by the random re-distribution of the data points. The *error bars* reflect the standard errors of the mean for all conversations within each *diagonal line*

48.6 % of the time. The chance that staff and clients look at each other within these interactions is 66.2 % * 48.6 % = 33.2 %. Figure 4 shows an example of the results of a LOS-profile analysis for gaze synchrony. The upper curve (diamonds) shows the real-life conversation, whereas the lower curve (squares) is the result of the LOS-profile analysis with shuffled time series. That is, with the temporal structure of the time series destroyed by the random re-distribution of the data points.

As Fig. 4 shows, the real-life data of the gaze patterns in general does not significantly distinguish themselves from the shuffled data. Therefore it is justified to conclude that although staff and clients look at each other more often than statistically could be expected, on average there seems to be no coordination of gaze patterns. However, as stated, there exists a wide variety among the individual interactional patterns. In a few interactions we did find a RR_{peak} for gaze patterns, which represents a maximal level at which the gaze patterns were synchronized. Figure 5a shows an example of an interaction in which the gaze patterns were not coordinated and Fig. 5b shows an example of an interaction in which the gaze patterns were coordinated.

The mean recurrence rate of the speech rhythm, that is, the global percentage of one interlocutor speaking while the other is silent is 51 % (Table 5: Global recurrence rate speech rhythm) and the average percentage that this matching behavior occurs at the same time is 60 % (Table 5: Line of Synchrony speech rhythm). The average recurrence rate of matching speech rhythms around the line of synchrony is 55 % (see Table 5). Here also, the ranges show a huge variety among the nineteen social interactions. Statistically speaking, matching behaviors (one speaking, while the other is silent) occur on average 50 % of the time (two of the four combinations), the recurrence rates generally do not give distinctive information in terms of coordination. Therefore another measure, the RR_{Peak} must be considered. The RR_{peak} is the maximum value (Mean = 67 %, ranges 58–74 %) in which matching behaviors occur. That is, staff and clients matched their turn to speak or

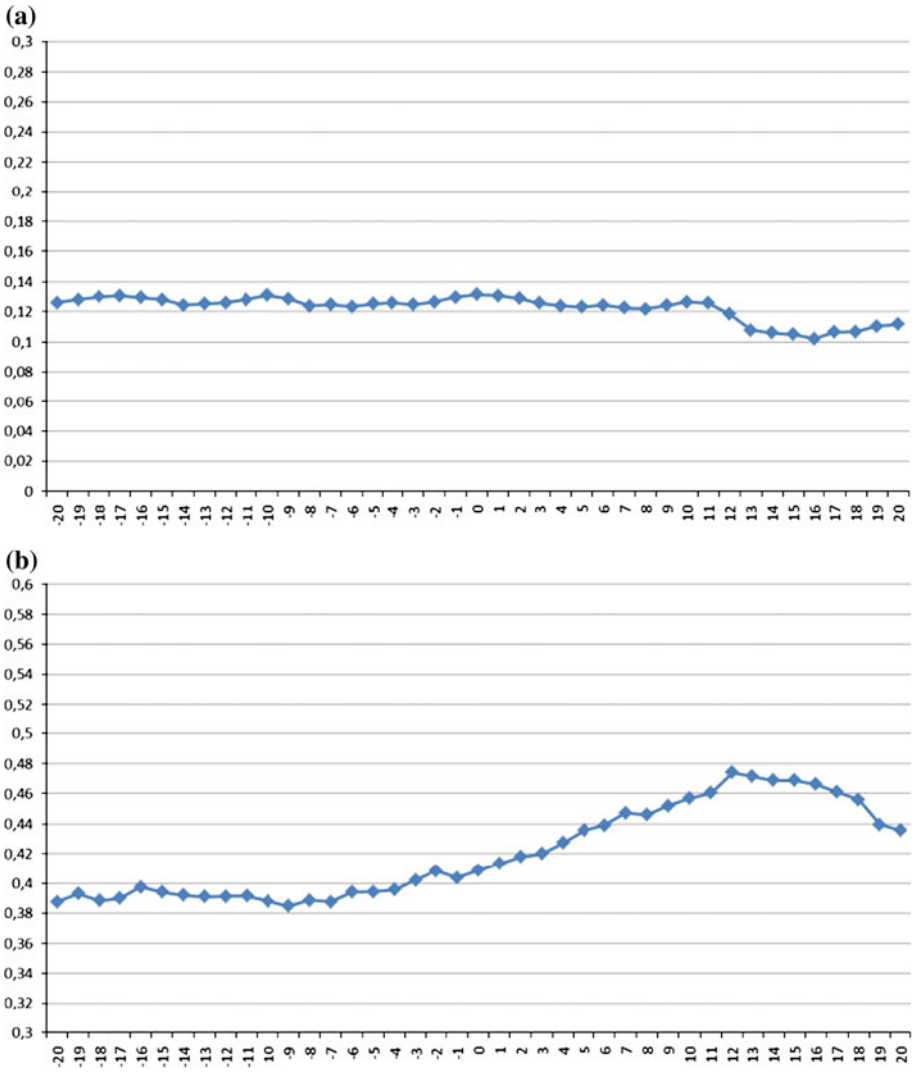

Fig. 5 **a**, **b** Two examples of individual LOS-profiles for gaze direction. **a** representing a dyad in which no coordination of gaze directions has been found and **b** representing a dyad in which coordination of gaze directions has been found

to keep silent in response to one another given a certain time delay (τ_{peak}, see below), about 67 % of their conversation. The existence of this peak, which is absent for the gaze direction, means that clients' and staff 's speech rhythms were synchronized. Figure 6 shows an example of a LOS-profile in which the RR_{peak} of speech patterns reached a maximum value of 74 %.

The results of the attunement and synchronization of the staff and clients' nonverbal behaviors revealed that their speech rhythms are generally more coordinated and synchronized than their gaze directions.

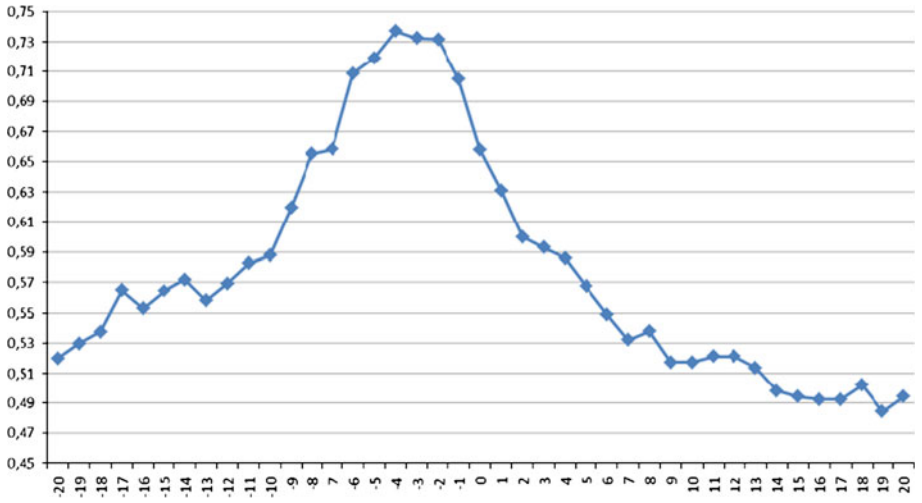

Fig. 6 An example of an individual LOS-profile for speech synchrony

(2) What Is the Pattern of Dominance in the Dialogue, in Relation to Interlocutors Initiating Nonverbal Behaviors Such As Gaze Direction or Following the Other's Lead?

In this section we will describe two variables that quantify the balance of the interaction in terms of initiating/leading or following nonverbal behavior of the other. As said, no significant results were found for gaze direction. We can, therefore, only present the results for the speech rhythms. The first variable is the τ_{peak}, which is the shift where the RRpeak is obtained, and it tells us about the delay in optimal matching between the interlocutors. In other words, this variable gives us information on the response time of one interlocutor to the other. The mean τ_{peak} is -3.38, which means that staff generally react about 3.5 s later to the nonverbal behavior of the client than the client does. For example, it might take staff 3.5 s longer to become silent when a client starts talking than a client needs to become silent when staff starts talking. It appears that in 12 of the 16 interactions (the first three interactions did not have a peak), staff have a longer response time than clients ($\tau_{peak} < 0$), indicating that in these interactions staff are more dominant and leading the conversation nonverbally. There is a wide variety in the interactions for τ_{peak} and one interaction shows that staff responded to the client with a delay of 19 s.

The second variable is the difference between the total relative amount of recurrence in the LOS-profile on both sides of the LOS (i.e., the sum of RR_{diag}, which equals the area under the curve, left and right from 0 in Fig. 3) and is a sign of how strongly one of the interlocutors is dominating the conversation. The mean value of the difference between staff and clients initiating speech rhythm is 0.83 %, which means that interactions are rather balanced in terms of initiating or following one another's speech rhythms. The ranges show a wide variety from -6.9 to 7.6 %, which means that in the most unbalanced interaction in terms of initiating or following the speech rhythm, staff initiated the speech rhythms 7.6 % more often than the client. In another interaction the client initiated the speech rhythms 6.9 % more often than staff. Analysis revealed that in 13 of the 19 interactions staff are dominant, indicating that staff initiate the speech rhythms more often than clients.

(3) Are Key Elements of Staff and Clients' Coded Nonverbal Behavior (Levels of Attunement and Dominance) Associated with Observer Ratings of the Quality of the Interactions?

These findings indicate whether the observers' judgments about the quality of the interactions are associated with the synchronization of nonverbal behaviors in the interactions. The results are presented in Table 6.

As Table 6 shows there are associations between the observer ratings of clients and the RR_{peak} of the speech rhythms. The RR_{peak} can be viewed as a measure of fine-tuning. The better staff and clients are attuned to each other when it comes to on–off vocal activity, the more clients believe that staff are actually listening; the higher clients value the way staff discuss the topics the better the overall impression of observer clients on the interaction. Noticeable is the fact that no associations have been found between observer ratings of staff and the RR_{peak} of speech rhythms, or between the other CRQA based measures. This suggests that staff were less sensitive to the coordination of staff and clients when it comes to taking turns in speaking. Staff were also less sensitive to the synchronization of the gaze direction than clients. Table 6 reveals that clients were sensitive to the percentage staff and clients look at each other at the same time: A positive association was found by the percentage of synchrony of gaze direction and the overall impression of the interactions rated by clients.

In fact, staff observers appear to be more sensitive to the difference in dominance between staff and clients in terms of initiating or following the speech rhythms (recall, data of the gaze direction were absent). Staff observers believed that staff listen better to the client when the client initiated the speech patterns more often, for example to start or stop talking. These findings are in line with the negative association between staff talking and staff's observer ratings on the willingness of the client to discuss the items (goals and subject) and a positive association between clients' talking and staff's observer ratings on the willingness of the client to discuss the items (goals and subject). Noticeable is the fact that neither clients nor staff based their ratings on the delay in the optimal matching between the interlocutors.

The results of the last research question are in line with the results found with the central-tendency measures. Staff and clients based their judgments of the quality of the interactions on different aspects of the interaction. Clients were more sensitive to coordination and fine-tuning for both speech rhythms and gaze directions. Staff were more sensitive to the quantitative dominance in speech rhythms.

Discussion

In the present study, the attunement and synchronization of staff–client interactions were examined. The results of the interactional analysis found in this study demonstrated that staff's and clients' speech rhythms are coordinated. With respect to the gaze directions, staff and clients did not reach an optimal point at which the respective tendencies to look at each other were attuned. This so called RR_{peak} for gaze directions was found in other studies by Richardson et al. (Richardson and Dale 2005; see also Richardson et al. 2007). They found that the eye movements of interlocutors were coupled during discourse and that this reflected the success of their communication. Richardson and Dale (2005), however, studied the synchronization of gaze patterns while interlocutors were staring at a visual display, whereas in our study we investigated the gaze patterns during face-to-face

Table 6 Pearson correlations between CRQA measures and observer ratings

	RR gaze patterns	% Synchrony of gaze direction	RR speech rhythms	% Synchrony of speech patterns	RR client–RR staff speech patterns	RR_{peak} speech rhythm	RR relative difference peak speech patterns	τ_{peak} speech patterns
Relation observed by clients	0.37	0.41	0.15	0.32	0.31	0.68**	0.46	−0.23
Goal observed by clients	0.37	0.45	−0.09	0.31	0.24	0.57*	0.08	−0.12
Method observed by clients	0.4	0.43	0.21	0.4	0.4	0.7**	0.45	−0.23
Overall impression observed by clients	0.42	0.47*	0.03	0.31	0.26	0.61*	0.3	0
Relation observed by staff	0.05	0.1	−0.19	−0.12	0.34	0.07	−0.28	−0.46
Goal observed by staff	0.04	0.15	−0.25	−0.1	0.18	−0.12	−0.47	−0.36
Method observed by staff	−0.06	−0.04	−0.18	−0.17	0.26	0.2	−0.17	−0.42
Overall impression observed by staff	−0.01	0.03	−0.13	−0.18	0.2	0.22	−0.1	−0.42

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

interactions. The absence of the RR_{peak} for gaze directions in this study may be explained by the fact that clients look significantly less often at staff than vice versa. There is no clear explanation as to why clients have a tendency to look away more often than staff. Several studies indicated that looking away is, among other functions, an indication of planning utterances or concentrating on complex cognitive tasks (Argyle and Cook, 1976; Novick et al. 1996). This raises questions on the level of the cognitiveload of the interactions for clients. Recent research on the coordination of gaze patterns has demonstrated that gaze patterns embody the joint understanding involved in communication (Shockley et al. 2009). For example, more shared knowledge between two individuals results in a convergence of their patterns of gaze (Richardson et al. 2007).

Studies on communication between staff and clients have emphasized the mismatch between the complexity of staff communication and the level of understanding of clients with ID (Bartlett and Bunning 1997; Bradshaw 2001; McConkey et al. 1999; Zilber et al. 1994). Another function of looking at the other is to signal attention and interest. If staff looked significantly more often at clients then it appears that clients are less involved in the interactions. When clients are less involved in the interactions, this may be an indication of the fact that they want to talk about something else. Thus, a possible interpretation is that this pattern of gaze reflects a tension between the clients and staff members, because they want to talk about different topics or did not appreciate the direction in which the conversation was going. Future research could tap into the perceptions of both staff and clients on what they want to achieve or talk about during social interactions (Duchan 1986).

There are, however, other explanations for this gaze pattern during interactions. Schmidt and O'Brien (1998) suggested that staff might look longer to indicate to their hesitant conversational partner that they are available for communication. It may also be that some clients look away more often because of inter-personal sensitivity or difficulties. It is known that people with Autistic Spectrum Disorder have difficulty maintaining eye contact. More studies revealed that interactional synchrony breaks down when people have particular social-cognitive deficits such as autism (Isenhower et al. 2012; Trevarthen and Daniel 2005).

The notion that clients prefer to avoid the gaze of staff was not confirmed by the client observers who were asked to observe the videos of the interactions and rate their quality. These client observers evaluated the quality of the interactions more positively when staff and clients looked at each other more often and when their gazes were better synchronized. However, there was no association between staff ratings of the interactions and the synchrony between staff's and clients' eye contact.

With respect to speech rhythms, coordination was found between staff and clients based on the RR_{peak}. Staff and clients generally reached an optimal point at which their tendencies to be talkative alternate, resulting in fewer moments of talking across one another and silent pauses. These findings are consistent with the mutual entrainment of speech rhythms found in other studies, for example in studies on conversations between psychology students (McGarva and Warner 2003). This suggests that staff and client interactions do not differ from other conversations in terms of coordinating vocal activity. Garva and Warner also found that mutual entrainment of speech rhythms were not associated with observer ratings of conversation quality.

In the present study, we found that mutual entrainment of speech rhythms did not affect ratings of conversation quality evaluated by staff observers, but did affect the ratings of conversation quality evaluated by client observers, suggesting that this is an aspect of the underlying dynamics of nonverbal behavior that the clients were sensitive to. This is an important finding because it demonstrates the ability of people with intellectual disabilities

to detect implicit social cues. Note that, staff observers were sensitive to how much the staff members in the interactions dominated the talk. The more staff in the interactions talked, the lower the quality rating of the interaction. The more the clients talked, the more positively the staff observers rated the interactions. It is possible that staff view clients talking more as evidence of empowerment or successful client centered approaches. This contrasts with the more nuanced nonverbal dynamical patterns that reflect greater mutuality between the staff and clients and raises an important question about staff's and clients' different perceptions about what constitutes a desirable interaction with one another. Staff may be focusing on the verbal aspects of communication and helping clients to have their say, at the expense of trying to achieve a proper mutual exchange underpinned by a synchrony of nonverbal behaviors. Thus, staff might indeed be helping people to have a say but this may sometimes be at the expense of achieving a proper rapport. In other words, staff may be making a conscious effort to be person centered and, in doing so, override their tacit inter-personal skills that allow nonverbal behaviors to be synchronized. This has important implications for staff training and recognizing that a focus on verbal behavior alone might not be sufficient for client to feel that they are afforded a proper role in the interaction.

The second research question was whether clients or staff dominated the interactions in terms of initiating/leading through specific nonverbal behaviors. No clear results were found for gaze directions. However, for speech rhythms it appeared that staff led in 13 of the 19 interactions. This means that in general, staff initiated the nonverbal elements of behavior more often and clients followed the staff initiatives. Moreover, when clients initiate the interaction, staff generally took significantly longer to follow their lead than it took for clients to follow staff. These findings are in line with the finding that the relationship between staff and clients is generally unbalanced: The client needs support and the professional is expected to have the knowledge, skills, and attitude to provide this. As imitation of socially dominant individuals is likely (van Baaren et al. 2009) and synchronization shares features with imitation, any asymmetry in roles should bring an asymmetry in synchrony (Louwerse et al. 2012).

These findings also imply that the CRQA measures can provide information that is not visible in central-tendency measures, where no difference was found between quantitative dominance of how long staff and clients spoke for. Although staff initiate speech rhythms more often than clients, the difference between staff and clients initiating the speech rhythms was relatively small ($M = 0.83$ %, $SD = 3.6$ %). This suggests that staff–client interactions are fairly balanced in terms of leading or following nonverbal behavior. These findings correspond with the balance in staff–client interactions in terms of power distribution pertaining to verbal behavior found in a study by Reuzel et al. (2012). Client observers were not sensitive to the balance in the interactions in terms of initiating or following nonverbal behavior, but staff observers thought that staff listened better to clients when the clients initiated the speech rhythms more often.

The CRQA-based measures used in this study are promising with respect to understanding interactions as a mutual process in terms of coordinating and leading or following a dialogue. However, care needs to be taken in the interpretation of the nonverbal patterns found in this research. Although the association found between clients' ratings of the quality of the interactions and the coordination of speech patterns is remarkable, we do not know the precise role or function of the synchronization in staff–client social interactions. To understand what the patterns of speech rhythms and gaze directions actually mean, it is necessary to link the analysis more closely to an analysis of verbal behavior (e.g., Linell et al. 1988), and examine the patterns in the context of the daily interactions between staff

and clients. Therefore, further investigation is needed about what clients and staff find important about their collaborative relationship.

The results of this study show that staff and clients have a tendency to look at different aspects of an interaction. In general, staff are sensitive to balance in an interaction in terms of quantitative measures of talking and initiating or following the speech rhythms. Clients are sensitive to a finer level of attunement: speech rhythms and the amount of eye contact. The presence of these underlying dynamics in nonverbal patterns as revealed by CRQA and the fact that clients are sensitive to it provides valuable information on the relevancy of nonverbal aspects of an interaction according to clients. This is because better attunement between staff and clients can ultimately help to achieve mutual understanding and empower the client in the relationship.

Acknowledgments We thank clients and care staff of J.P. van den Bentstichting in the Netherlands for their participation.

References

Antaki, C., & Rapley, M. (1996). 'Quality of life' talk: The liberal paradox of psychological testing. *Discourse and Society, 7*, 293–316. doi:10.1177/0957926596007003002.

Antaki, C., Young, N., & Finlay, M. (2002). Shaping clients' answers: Departures from neutrality in care-staff interviews with people with a learning disability. *Disability and Society, 17*, 435–455. doi:0.1080/09687590220140368.

Argyle, M., & Cook, M. (1976). *Gaze and mutual gaze*. Cambridge: Cambridge University Press.

Bartlett, C., & Bunning, K. T. (1997). The importance of communication partnerships: A study to investigate the communicative exchanges between staff and adults with learning disabilities. *British Journal of Learning Disabilities, 25*, 148–153. doi:10.1111/j.1468-3156.1997.tb00030.x.

Bernieri, F. J., & Rosenthal, R. (1991). Interpersonal coordination: Behavior matching and interactional synchrony. In R. S. Feldman & B. Rime (Eds.), *Fundamentals of nonverbal behavior* (pp. 401–432). NY: Cambridge University Press.

Bradshaw, J. (2001). Complexity of staff communication and reported level of understanding skills in adults with intellectual disability. *Journal of Intellectual Disability Research, 45*, 233–243. doi:10.1046/j.1365-2788.2001.00318.x.

Cacioppo, J. T., Visser, P. S., Pickett, C. L., et al. (2006). *Social neuroscience: People thinking about thinking people*. Cambridge, MA: MIT Press.

Cappella, J. N., & Planalp, S. (1981). Talk and silence sequences in informal conversations iii: Interspeaker influence. *Human Communication Research, 7*(2), 117–132.

Chapple, E. D. (1970). *Culture and biological man: Explorations in behavioral anthropology*. NY: Holt, Rinehart & Winston.

Chartrand, T. L., & Bargh, J. A. (1999). The chameleon effect: The perception-behavior link and social interaction. *Journal of Personality and Social Psychology, 76*, 893–910. doi:10.1037/0022-3514.76.6.893.

Church, K. W. (1993). Char align: A program for aligning parallel texts at the character level. In *Proceedings of the 31st annual meeting of the association for computational linguistics* (Vol. 31, pp. 1–8).

Dale, R., & Spivey, M. J. (2005). Categorical recurrence analysis of child language. In *Proceedings of the 27th annual meeting of the cognitive science society* (pp. 530–535). Mahwah, NJ: Lawrence Erlbaum.

Dale, R., & Spivey, M. J. (2006). Unraveling the dyad: Using recurrence analysis to explore patterns of syntactic coordination between children and caregivers in conversation. *Language Learning, 56*, 391–430. doi:10.1111/j.1467-9922.2006.00372.x.

de Graag, J. A., Cox, R. F. A., Hasselman, F., Jansen, J., & de Weerth, C. (2012). Functioning within a relationship: Mother-infant synchrony and infant sleep. *Infant Behavior and Development, 35*, 252–263. doi:10.1016/j.infbeh.2011.12.006.

Delaherche, E., Chetouani, M., Mahdaoui, A., Saint-Georges, C., Viaux, S., & Cohem, D. (2012). Interpersonal synchrony: A survey of evaluation methods across disciplines. *IEEE Transactions on Affective Computing, 3*, 349–365. doi:10.1109/T-AFFC.2012.12.

Duchan, J. F. (1986). Language intervention through sense-making and fine tuning. In R. L. Schiefelbusch (Ed.), *Language competence, assessment and intervention* (pp. 75–84). NY: College Hill Press.

Duncan, B., Miller, S., & Sparks, J. (2004). *The heroic client: A revolutionary way to improve effectiveness through client directed, outcome informed therapy*. San Francisco: Jossey Bass.

Eckmann, J. P., Kamphorst, S. O., & Ruelle, D. (1987). Recurrence plots of dynamical systems. *Europhysics Letters, 5*, 973–977. doi:10.1209/0295-5075/4/9/004.

Finlay, W. M. L., Walton, C., & Antaki, C. (2008). Promoting choice and control in residential services for people with learning disabilities. *Disability and Society, 23*, 349–360. doi:10.1080/09687590802038860.

Fowler, C. A., Richardson, M. J., Marsh, K., & Shockley, K. D. (2008). Language use, coordination and the emergence of cooperative action. In A. Fuchs & V. Jirsa (Eds.), *Coordination: Neural, behavioral and social dynamics* (pp. 161–180). Berlin: Springer.

Giles, H., Coupland, J., & Coupland, N. (1991). Accommodation theory: Communication, context, and consequences. In H. Giles, J. Coupland, & N. Coupland (Eds.), *Contexts of accommodation: Developments in applied sociolinguistics* (pp. 1–68). Cambridge: Cambridge University Press.

Goodwin, C. (1981). *Conversational organization: Interaction between speakers and hearers*. NY: Academic Press.

Hove, M. J., & Risen, J. L. (2009). It's all in the timing: Interpersonal synchrony increases affiliation. *Social Cognition, 27*, 949–960. doi:10.1521/soco.2009.27.6.949.

Hutchins, E. (1995). *Cognition in the wild*. Cambridge, MA: MIT Press.

Isenhower, R. W., Marsh, K. L., Richardson, M. J., Helt, M., Schmidt, R. C., & Fein, D. (2012). Rhythmic bimanual coordination is impaired in children with autism spectrum disorder. *Research in Autism Spectrum Disorders, 6*, 25–31. doi:10.1016/j.rasd.2011.08.005.

Jahoda, A., Dagnan, D., Kroese, B. S., Pert, C., & Trower, P. (2009). Cognitive behavioural therapy: From face to face interaction to a broader contextual understanding of change. *Journal of Intellectual Disability Research, 53*, 759–771. doi:10.1111/j.1365-2788.2009.01189.x.

Jingree, T., Finlay, W. M. L., & Antaki, C. (2006). Empowering words, disempowering actions: An analysis of interactions between staff members and people with learning disabilities in residents' meetings. *Journal of Intellectual Disability Research, 50*, 212–226. doi:10.1111/j.1365-2788.2005.00771.x.

Leudar, I. (1981). Strategic communication in mental retardation. In W. I. Fraser & R. Grieve (Eds.), *Communication with normal and retarded children* (pp. 113–129). Bristol, UK: John Wright and Sons.

Lichtwarck-Aschoff, A., Hasselman, F., Cox, R. F. A., Pepler, A., & Granic, I. (2012). A characteristic destabilization profile in parent–child interactions associated with treatment efficacy for aggressive children. *Nonlinear Dynamics, Psychology, and Life Sciences, 16*, 353–379. Pubmed: 22695153.

Linell, P., Gustavsson, L., & Juvonen, P. (1988). Interactional dominance in dyadic communication: A presentation of initiative-response analysis. *Linguistics, 26*, 415–442. doi:10.1515/ling.1988.26.3.415.

Louwerse, M. M., Dale, R., Bard, E. G., & Jeuniaux, P. (2012). Behavior matching in multimodal communication is synchronized. *Cognitive Science, 1*, 1–24. doi:10.1111/j.1551-6709.2012.01269.

Marwan, N., Romano, M. C., Thiel, M., & Kurths, J. (2007). Recurrence plots for the analysis of complex systems. *Physics Reports, 438*(5–6), 237–329. doi:10.1016/j.physrep.2006.11.001.

McConkey, R., Morris, I., & Purcell, M. (1999). Communications between staff and adults with intellectual disabilities in naturally occurring settings. *Journal of Intellectual disabilities Research, 43*, 194–205. doi:10.1046/j.1365-2788.1999.00191.x.

McGarva, A. R., & Warner, R. M. (2003). Attraction and social coordination: Mutual entrainment of vocal activity rhythms. *Journal of Psycholinguistic Research, 32*, 335–354. doi:0090-6905/03/0500-0335/0.

McNeill, D. (1992). *Hand and mind: What gestures reveal about thought*. Chicago, IL: University of Chicago Press.

Miles, L. K., Nind, L. K., & Macrae, N. (2009). The rhythm of rapport: Interpersonal synchrony and social perception. *Journal of Experimental Social Psychology, 45*, 585–589. doi:10.1016/j.jesp.2009.02.002.

Moore, D. G. (2001). Reassessing emotion recognition performance in people with mental retardation: A review. *American Journal on Mental Retardation, 106*, 481–502. doi:10.1352/0895-8017(2001)106<0481:RERPIP>2.0.CO;2.

Noldus. (2009). *The observer XT*. Wageningen, The Netherlands: Noldus Information Technology.

Novick, D., Hansen, B., & Ward, K. (1996). Coordinating turn-taking with gaze, *Proceedings of the International Conference on Spoken Language Processing (ICSLP-96)*, Philadelphia, PA, October, 1996, 3, 1888-91.

Reuzel, E., Embregts, P. J. C. M., Bosman, A. M. T., van Nieuwenhuijzen, M., & Jahoda, A. (2012). Interactional patterns between staff and clients with borderline to mild intellectual disabilities. The nature of staff client social interactions. *Journal of Intellectual Disability Research*. doi:10.1111/j.1365-2788.2011.01515.x.

Richardson, D. C., & Dale, R. (2005). Looking to understand: the coupling between speakers' and listeners' eye movement and it's relationship to discourse comprehension. *Cognitive Science, 29*, 1045–1060. doi:10.1207/s15516709cog0000_29.

Richardson, D. C., Dale, R., & Kirkham, N. Z. (2007). The art of conversation is coordination. *Psychological Science, 18*, 407–413. doi:10.1111/j.1467-9280.2007.01914.x.

Sacks, H. (1992). *Lectures on conversation* (Vol. II). Cambridge, MA: Blackwell.

Schmidt, R. C., Morr, S., Fitzpatrick, P. A., & Richardson, M. J. (2012). Measuring the dynamics of interactional synchrony. *Journal of Nonverbal Behavior, 36*, 263–279. doi:10.1007/s10919-012-0138-5.

Schmidt, R. C., & O'Brien, B. (1998). Modeling interpersonal coordination dynamics: Implications for a dynamical theory of developing systems. In P. C. Molenaar & K. Newell (Eds.), *Dynamic systems and development: Beyond the metaphor* (pp. 221–240). Mahwah, NJ: Erlbaum.

Sebanz, N., Bekkering, H., & Knoblich, G. (2006). Joint action: Bodies and minds moving together. *Trends in Cognitive Sciences, 10*(2), 70–76. doi:10.1016/j.tics.2005.12.009.

Shockley, K., Butwill, M., Zbilut, J. P., & Webber, C. L. (2002). Cross recurrence quantification of coupled oscillators. *Physics Letters, 305*, 59–69. doi:10.1016/S0375-9601(02)01411-1.

Shockley, K., Richardson, D. C., & Dale, R. (2009). Conversation and coordinative structures. *Topics in Cognitive Science, 1*, 305–319. doi:10.1111/j.1756-8765.2009.01021.x.

Social Exclusion Unit. (2005). *Improving services, improving lives: Evidence and key themes. Interim report*. London: Office of the Deputy Prime Minister.

Street, R. L. (1984). Speech convergence and speech evaluation in fact finding interviews. *Human Communication Research, 11*, 139–169. doi:10.1111/j.1468-2958.1984.tb00043.x.

Tickle-Degnen, L., & Rosenthal, R. (1990). The nature of rapport and its nonverbal correlates. *Psychological Inquiry, 1*, 285–293. doi:10.1207/s15327965pli0104_1.

Trevarthen, C., & Daniel, S. (2005). Disorganized rhythm and synchrony: Early signs of autism and Rett syndrome. *Brain and Development, 27*, S25–S34. doi:10.1016/j.braindev.2005.03.016.

van Baaren, R., Janssen, L., Chartrand, T., & Dijksterhuis, A. (2009). Where is the love? Social aspects of mimicry. *Philosophical Transactions of the Royal Society B, Biological Sciences, 364*, 2381–2389. doi:10.1098/rstb.2009.0057.

Von Heijne, G. (1987). *Sequence analysis in molecular biology: Treasure trove or trivial pursuits?*. San Diego, LA: Academic Press.

Warner, R. M. (1992). Sequential analysis of social interaction: Assessing internal versus social determinants of behavior. *Journal of Personality and Social Psychology, 63*, 51–60. doi:10.1037/0022-3514.63.1.51.

Webber, C. L., Jr., & Zbilut, J. P., (2005). Recurrence quantification analysis of nonlinear dynamical systems. In M. A. Riley & G. C. Van Orden (Eds.), *Tutorials in contemporary nonlinear methods for the behavioral sciences* (pp. 33–101). Retrieved March 1, 2005, from http://www.nsf.gov/sbe/bcs/pac/nmbs/nmbs.jsp.

Zaja, R., & Rojahn, J. (2008). Facial emotion recognition in intellectual disabilities. *Current Opinion in Psychiatry, 21*, 441–444. doi:10.1097/YCO.0b013e328305e5fd.

Zbilut, J. P., & Webber, C. L., Jr. (1992). Embeddings and delays as derived from quantification of recurrence plots. *Physics Letters A, 171*, 199–203. doi:10.1016/0375-9601(92)90426-M.

Zilber, D., Shaddock, A., Dowse, L., Rawlings, M., Guggenheimer, S., & Browne, F. (1994). Communication patterns in services for people with severe intellectual disabilities: Function, form, and responsiveness. *Australian Journal of Human Communication Disorders, 22*, 85–98.