J Nonverbal Behav (2014) 38:355–376
DOI 10.1007/s10919-014-0179-z

ORIGINAL PAPER

Synchronization of Nonverbal Behaviors in Detecting Mediated and Non-mediated Deception

Norah E. Dunbar · Matthew L. Jensen · Debra Conly Tower · Judee K. Burgoon

Published online: 12 April 2014

Abstract Videoconferencing (VC) is changing the way people communicate in a variety of fields including education, medicine, business, and even interpersonal relationships. In this study, we investigate the effects of the modality of communication, whether through face-to-face (FtF) or VC, on the ability of interactants to develop and maintain nonverbal synchrony. This study is an analysis of 101 interviews between students and professional interviewers in which some of the participants were induced to cheat on a task with a confederate. The results revealed that the VC modality hampered the interactional synchrony of the dyads, especially during the phases of questioning when suspicion-inducing or accusatory questioning was used. For global ratings of synchrony, the greatest impact of modality was for participants whose lies were not sanctioned by the interviewer, suggesting that the VC modality negatively affected the most skilled deceivers. In addition, interactional synchrony improved in the final, accusatory, phase of the interview when subjects confessed, particularly in the FtF modality. The effects of the interviewer and the question type are also discussed.

Keywords Nonverbal synchrony · Interpersonal adaptation · Computer-mediated communication · Deception detection

A version of this paper that included a small subset of these analyses was presented at the 44th Hawaii International Conference on System Sciences in Maui, HI.

N. E. Dunbar (✉)
Center for Applied Social Research and Department of Communication, University of Oklahoma, 610 Elm Ave. Room 101, Norman, OK 73019, USA
e-mail: ndunbar@ou.edu

M. L. Jensen
Center for Applied Social Research and Division of Management Information Systems, Price College of Business, University of Oklahoma, Norman, OK, USA

D. C. Tower
Center for Applied Social Research, University of Oklahoma, Norman, OK, USA

J. K. Burgoon
Center for the Management of Information, University of Arizona, Tucson, AZ, USA

Introduction

Video-Mediated Teleconferencing or "videoconferencing" (VC) is changing the way people communicate when they are geographically separated. Inexpensive programs like Skype or Facetime and ready access to cameras on laptops, tablets, and smartphones have made it possible to communicate visually from virtually anywhere. VC is often touted by business as a way to reduce costs and travel time for employees, as well as reduce the environmental impact of air travel (Lewis et al. 2009). Researchers have examined the effectiveness of VC as a mode of communication in education (Lawson and Comber 2010; McHenry and Bozik 1995), in therapeutic or psychiatric settings (Antonacci et al. 2008; Taylor 2011), and in both short- and long-term work groups (Fuller and Dennis 2009; Webster 1998).

A recent review of the empirical research on VC suggests that it has both strengths and limitations compared to face-to-face (FtF) communication and less immersive technologies like text and audio-only modalities (Walther 2011). One area in which the effectiveness of VC has not been adequately explored is in law enforcement interviews, especially when the purpose is to detect deceptiveness of suspects or witnesses. With VC, highly skilled interviewers could question suspects or witnesses without regard for geographic separation. Legal scholars have discussed the implications of conducting remote interviews (Davies 2007) but few studies have examined whether VC interferes with experts' ability to establish rapport and detect deception accurately. This study addressed this issue by examining the nonverbal synchrony of experts interviewing students who participated in a collaborative task and, in some cases, cheated. We compared FtF to VC to assess whether the modality would affect nonverbal synchrony as well as experts' ability to discriminate between truth and deception and elicit confessions.

Nonverbal Synchrony, Modality Effects, and Deception Detection

The subtle and significant way individuals influence each other can be seen through their nonverbal synchrony. Synchrony refers to "similarity in rhythmic qualities and enmeshing or coordination of the behavioral patterns of both parties" in an interaction (Burgoon et al. 1995, p. 128). Nonverbal reciprocity with others is considered foundational to human interaction and essential to preserving social order and maintaining successful relationships (Burgoon et al., in press; Cappella 1997b; Gouldner 1960). Cappella (1990, 1991, 1997a) identifies the variety of ways in which the above may manifest itself, such as: accents, speech rate, vocal intensity, postural and gestural behaviors, movement, gaze, facial affect, and self-disclosure. We explored many of these forms in this examination of deception and interactional synchrony.

Burgoon et al. (1995) make the argument that we are naturally inclined toward synchrony or mutual adaptation because meshing with movements, tempo, and linguistic patterns of partners is both a polite and natural form of behavior. Giles et al. (Gallois et al. 2005; Giles 2008) argue that the status of the partners also plays a role because low status interactants are more likely to entrain their behaviors with the high status partner than vice versa. In the case of deception detection, if we are naturally inclined toward synchrony, there may be little difference between truth-tellers and deceivers initially because deceivers will be attempting to approximate the normal conversational pattern of truth-tellers. If the conversation turns toward the subject about which the deceivers are planning to lie or the interviewer directly questions them, the rapport they have established may begin to break down. Levine et al. (2010) reported that compared to background questioning at the beginning of an interview, direct event-specific questioning about which participants were asked to lie later in the interview made deceivers more transparent and more likely to

confess. We propose that one cause of this increased transparency is dissynchrony which can be used as an indicator of deceptiveness.

However, to our knowledge, no one has examined the interactional synchrony present in VC interactions compared to FtF. Research on users' experience with VC as a mode of communication has suggested that it can be just as satisfying as FtF (Lowden and Hostetter 2012) and that certain nonverbal cues of synchrony like mutual eye gaze can be captured in VC (Roberts et al. 2009). Compared to leaner modalities like text and audio channels, VC allows for a greater sense of social presence or "a sense of being with another" in the virtual environment (Biocca et al. 2003). Compared to FtF, however, VC may suffer in terms of both social presence and interactional synchrony because the subtle cues of turn-taking are harder to discern or are occluded when using VC. Synchrony can be further disrupted if the camera only captures the head instead of the hands and body, or the signal causes lags between speaking turns. In a prior study, we theorized that while engagement and enmeshment are hallmarks of unmediated FtF interaction, the limits of VC technology may hamper the ability to create a normal, synchronous interaction rhythm with seamless turn-taking that undergirds the creation of rapport and mutuality (Dunbar et al. 2013). Hypothesis 1 tested that prediction:

H1 Interactional synchrony will be lower in the VC modality than the FtF modality.

Given that synchrony is a natural process in human interaction and is affected by social power and interpersonal competence, we also posit that this process will be hindered somewhat when one person introduces deceit. Inbau et al. (2013) suggest that compared to liars, truth-tellers may be more helpful because they will "play mental detective" and discuss possible suspects and motives with the investigator (p. 110). However, some research has found just the opposite: guilty suspects have a greater incentive to cooperate and try to point the interviewer toward another suspect (Vrij et al. 2007). On the other hand, truth-tellers may not maintain synchrony either if they are surprised or offended by the accusation, so there might be a greater detriment to nonverbal synchrony for truth-tellers than liars, especially if deceivers are highly skilled and can use the rapport established to appear innocent. Since there are competing theoretical stances about the effects of deception on interactional synchrony, we posit the following non-directional hypothesis:

H2 Interactional synchrony of the interviewer-interviewee dyad distinguishes between truthful and deceptive interviewees.

We followed an interview script used by other researchers in which the interviewer begins with background or innocuous questions (i.e., "Have you ever played a game like this before?"), then hints at wrongdoing with some suspicion-arousing questions (i.e., "If I told you that you did better than most groups, would that surprise you?"), and then asks questions that directly accuse the interviewee of wrongdoing (i.e., "Did you cheat?") (Levine et al. 2010). Thus, one might expect differences across those different types of questions. Normally, one would expect to see greater synchronization over the course of a conversation as participants build rapport and begin to settle into a pattern. However, accusations and even implied suspicion represent departures from the normal conversational flow the participant might be expecting. Recent studies on unexpected questions suggest they can be more diagnostic than expected questions (Warmelink et al. 2012, 2013). For unrehearsed deceivers, who must expend some cognitive resources constructing a plausible lie, the increase in cognitive load could also lessen the person's nonverbal enmeshment in the conversation and ability to "go with the flow." Thus, we pose the following hypothesis:

H3 Across three interview phases (background, suspicious, accusatory), interviewer-interviewee dyads will become less synchronized in their behavior.

From the perspective of law enforcement, one reason for establishing rapport and synchrony is not only to help the interviewer detect deception but also to increase the cooperativeness of the suspect and perhaps even encourage a confession (Inbau et al. 2013). In his analysis of the KUBARK Counterintelligence Interrogation Manual, Kleinman (2006) argues that interrogators often try to create rapport while simultaneously acting as detached observers, but even with years of training and experience, this is a complex task. If there is a disruption in synchrony due to the fact that the interrogator is revealing suspicion or making accusations, a subsequent confession might cause the dyad to relax and return to a more synchronized state. While manuals for interrogators presume that rapport leads to confessions, it is also possible that confessions lead to greater synchrony because the disruption caused by accusations has been resolved. We cannot separate out these causal mechanisms with the current data; however, we investigated whether synchrony and confessions are linked with the following research question:

RQ Is interactional synchrony related to the likelihood of a confession?

The Present Study

This investigation is a secondary analysis of data drawn from an experiment in which student participants were paired with a confederate to play a difficult trivia game and randomly assigned to a veracity condition (Dunbar et al. 2013). Following the game, participants were interviewed by professional examiners who tried to determine whether or not they cheated.

The three veracity conditions were: (1) *Truth*, in which no cheating took place and no lying occurred, (2) *Sanctioned deception*, in which participants who were induced to cheat were "caught" in the act by the research assistant and asked to lie to the interviewer about the cheating, and (3) *Unsanctioned deception*, in which participants who were induced to cheat were not "caught" and voluntarily lied about the cheating to the interviewer.

Whether or not deception is sanctioned by the experimenter is an important component to this study because while deception researchers normally ask a participant to lie in order to establish ground truth and allow for random assignment to conditions, researchers have recently begun to advocate the use of unsanctioned deception in order to preserve ecological validity (Levine et al. 2006). Levine et al. (2010) argue that unsanctioned liars who have chosen to lie will do so more readily when they have confidence in their own deception skill or believe they have honest demeanors that make them more difficult to detect. They suggested that only good liars will self-select into the deception condition in experiments in which they have a choice, thereby making them difficult to detect because of their confidence or demeanor. We attempted to find a balance between the internal validity of sanctioned lies and the ecological validity of unsanctioned lies by including both in our experiment (Dunbar et al. 2013). Whether there is a difference between sanctioned and unsanctioned deceivers in their interactional synchrony during their interviews was tested with H2 above.

Method

Sample

Stimulus videos ($N = 101$) were used from an existing dataset described in more detail by Dunbar et al. (2013) in which participants engaged in a game with a confederate and were

Table 1 Cell sizes for between-subjects factors

Factor	Level	*N*
Modality	FtF	56
	VC	45
Veracity	Truth	32
	Sanctioned	40
	Unsanctioned	29
Interviewer	1	20
	2	25
	3	33
	4	23

then interviewed by one of four professional interviewers (2 male, 2 female) who were certified polygraph examiners for the Department of Defense. Some of the interviews were conducted FtF and others via Skype (VC). The Skype interviews were conducted using the university's high speed Ethernet connection; the quality of the connection was generally good. The interviewers and participants, though in different rooms, were in the same building at the time of the interview in order to improve audio/video quality and reduce the potential for lag time.

In the previous study, the interviewers were able to correctly identify 59.8 % of the truth-tellers, 55.9 % of the sanctioned liars, and 61.1 % of the unsanctioned liars. Detection accuracy did not differ significantly between veracity conditions, and there was no difference between modalities (FtF vs VC) in the ability of the interviewers to discern truth-tellers from liars. Overall, 57.5 % of the sanctioned liars and 77.8 % of the unsanctioned liars confessed during the interview. Liars were just as likely to confess when the interviews were conducted via videoconferencing compared to FtF interviews. For the present analysis, since the unsanctioned condition had a disproportionately high confession rate, we selected all the unsanctioned non-confessors and then randomly selected cases from the other conditions to achieve a target of 100 cases. A breakdown of the cell sizes for each condition can be found in Table 1.

Because confessors ($n = 27$) did not fit cleanly into a veracity condition, they were excluded from the analyses of the relationship between interactional synchrony and deception (H1, H2, and H3) ($n = 74$). For the RQ examining synchrony and confessions, confessors were included in the analyses, but truth-tellers ($n = 32$) were excluded, leaving a remaining sample of 69.

Synchrony Coding

Raw videos from the experiment were rendered into split-screen presentations showing both the interviewer and participant. Behavioral observation and annotation were conducted on these videos by five trained coders using C-BAS, the C# Behavioral Annotation System (Meservy 2010), a computer-based software application to aid researchers in coding events on video or audio tracks. The coders attended two training sessions, each lasting approximately 1 h. The videos used during the training sessions were not included in the sample.

Synchrony was evaluated both locally and globally. Local synchrony assesses the occurrence of matching for micro-units of behavior, such as hand movement or smiling, whereas global synchrony involves a gestalt judgment about the coordination between the

Table 2 Synchrony coding instructions and observed frequency of behaviors

Type of synchrony	Description	Observed frequency Phase 1	Observed frequency Phase 2	Observed frequency Phase 3
Nodding or shaking	One person nods or shakes their head and the other interlocutor does the same concatenously	181	73	57
Facial mirroring	One person does a facial expression that the other mirrors (e.g., one person furrows the brow and the other does the same). Divided into:			
	Upper face (eyebrows and forehead)	64	42	30
	Lower face (mouth and chin)	380	94	83
Laughing along	One person laughs and the interlocutor laughs along	49	11	9

partners over the course of an interaction. The visual field of the VC dyads was limited to the head and shoulders of the partner, so the measures of local synchrony focused on the face and head movements. Researchers have found that different parts of the face tend to be associated with different synchrony behaviors. For example, negative emotion is associated with increased activity in the brow area, whereas positive emotion tends to be associated with activity in the lower face (Levenson 1996). In order to capture synchrony across emotions and behaviors, the different zones of the face were coded separately. In addition, coders evaluated the frequency of synchrony in head movement (nodding or shaking) as well as laughing along with the partner.

The coders worked in pairs and coded the interviews for the types of local synchrony found in Table 2. The teams watched the split-screen video and when an instance of synchrony was identified, the team discussed it, identified the type and described what occurred on-screen in a narrative format in a text box. The coders were also trained to evaluate global synchrony in each of the three phases of the interviews. First, the coders segmented each interview into the three phases based on the type of questions asked by interviewer. The questions found in each phase are identified in Table 3. After viewing each phase of the interview, the team was asked to rate the amount of synchrony the dyad displayed during that phase of questioning on a scale from 1 to 7 ranging from "*not at all in sync*" (1) to "*completely in sync*" (7). Means for each coded variable can be found in Table 4.[1]

Results

Two sets of analyses were performed, mixed model univariate analyses of variance testing global synchrony and multivariate mixed model analyses of covariance testing local synchrony. The first set of analyses tested the three hypotheses regarding the relationship between synchrony and modality (H1), whether synchrony distinguishes between truthful and deceptive participants (H2), and the impact of the types of questions on synchrony

[1] Analyses were conducted on the total counts of synchrony behaviors but as this was redundant with the results of global synchrony and the individual codes allowed for a more nuanced analysis, they are not reported here.

Table 3 Interview phases used in global coding

Background questions	1. What is your understanding of the purpose of this interview?
	2.Have you ever played a game like this before?
	3. How well do you think you did?
	4. Was teamwork a factor?
Suspicion questions	5. If I told you that you did better than most groups, would that surprise you?
	6. Are you aware of the prohibition against cheating in OU's honor code?
	7. If someone cheated in the experiment, what do you think should happen to them?
Direct accusation questions	8. Did you cheat?
	9. Would there be any reason that someone would say you cheated?
	10. If I told you that your participation in the trivia game was video recorded, would that change what you have to tell me?
	11. Why should I believe you?
	12. What do you think your partner would say if I asked the same question?
	13. Would you be willing to take a polygraph to verify your statement?

Table 4 Means of variables across the three phases of the interview

Code	Interview phase	*N*	Mean	SD
Global synchrony	Background	101	3.10	1.35
	Suspicious	101	2.03	1.18
	Accusatory	101	1.74	1.09
Lower face	Background	101	3.86	1.41
	Suspicious	101	2.04	1.01
	Accusatory	101	1.85	1.11
Upper face	Background	101	1.70	0.99
	Suspicious	101	1.49	0.83
	Accusatory	101	1.35	0.73
Laughing along	Background	101	1.54	0.90
	Suspicious	101	1.13	0.48
	Accusatory	101	1.11	0.43
Head nodding & shaking	Background	101	2.42	1.67
	Suspicious	101	1.71	1.13
	Accusatory	101	1.59	0.99

The means of global synchrony are based on the 1–7 Likert scale ratings. The means for the four measures of local synchrony are based on the transformed counts. For each measure, a score of 1 is a rating of no synchrony or a count of zero

(H3). The second set of analyses examined whether interactional synchrony is related to the likelihood of a confession (RQ).

Inspection of the counts of synchrony features revealed positive skewness. Therefore, we followed guidance from Snedecor and Cochran (1980) and used Freeman and Tukey's (1950) transformation for non-normal distributions, which resolved the skewness.[2] In each analysis of variance, the interview phase was the within-subjects factor (called Phase

[2] A score of 1 on the transformed counts indicates that there were no recorded observations of synchrony.

hereafter), the communication modality (FtF or VC) and the veracity (sanctioned lie, unsanctioned lie, truth) condition were between-subject factors. In addition, the original study of this dataset revealed differences according to the interviewer (Dunbar et al. 2013). Although the interviewers followed the same set of questions, they were free to ask follow-up questions to elicit additional information, and the interviewers varied in terms of experience, age, and style. Therefore, the interviewer (1–4) was also included as a blocking variable in each analysis in order to control for this effect. In addition, for the measures of local synchrony, interview duration was included as a covariate.

Analyses of Synchrony and Modality (H1), Interview Phase (H2), and Veracity (H3)

Global Synchrony

Global synchrony was analyzed in a 3 (interview phase: background, suspicion, accusatory) × 2 (modality: FtF, VC) × 3 (veracity: truth, sanctioned, unsanctioned) × 4 (interviewer) mixed model analysis of variance (ANOVA), with interview phase as a within-subjects factor and modality, veracity, and interviewer as between subject factors. The results are presented in Table 5. There were main effects for phase, $p < .001$, $\eta^2 = .55$ and modality, $p = .008$, $\eta^2 = .11$. There were also significant interaction effects for Phase × Modality, $p = .02$, $\eta^2 = .12$, and Phase × Interviewer, $p = .04$, $\eta^2 = .10$. The within-subjects contrasts revealed a significant quadratic relationship for the interview phase, $F(1, 63) = 10.95$, $p = .002$, $\eta^2 = .15$, and the Phase × Modality interaction, $F(1, 63) = 8.69$, $p = .004$, $\eta^2 = .12$, and a significant linear relationship for the Phase × Interviewer interaction, $F(3, 63) = 4.31$, $p = .008$, $\eta^2 = .17$. The participants and interviewers were generally more synchronized during background questioning (interview phase 1) than when the questions signaled suspicion (phase 2), or when the questions became more accusatory (phase 3), but modality affected this result (see Fig. 1).

Table 6 summarizes the significant Bonferroni-corrected pairwise comparisons for global synchrony. Pairwise comparisons between modalities at each interview phase detected no significant difference in global synchrony between the FtF and VC modalities in phase 1, $p = .23$, but VC dyads displayed significantly less global synchrony than FtF

Table 5 Mixed model analysis of variance for Phase × Modality × Veracity effects for global synchrony

Source	Value	df_1	df_2	F	p	η^2
Between						
Interviewer (I)	6.31	3	63	2.65	.057	.11
Modality (M)	17.69	1	63	7.43	.008	.11
Veracity (V)	.29	2	63	.12	.887	.00
M × V	2.28	2	63	.96	.390	.03
Within						
Phase (P)	.45	2	62	38.49	.000	.55
P × M	.88	2	62	4.28	.018	.12
P × V	.96	4	124	.71	.584	.02
P × M × V	.94	4	124	.94	.444	.03
P × I	.81	6	124	2.23	.044	.10

Within-Subjects F ratios are Wilks' approximation of F. Sample ($n = 74$) includes non-confessors only

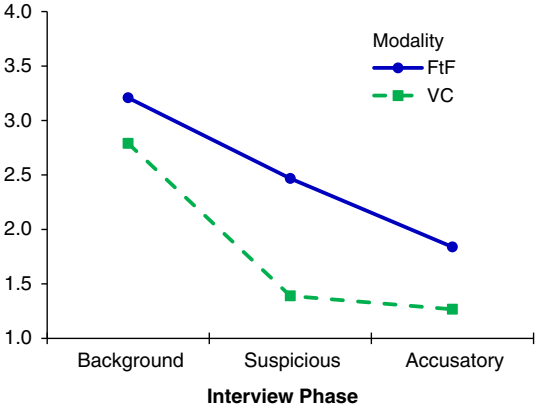

Fig. 1 Modality main effect for global synchrony across interview phases

Table 6 Significant Bonferroni-corrected pairwise comparisons for global synchrony

Effect	Measure		Paired comparisons		M_{diff}	*SE*	*p*	95 % CI	
								L	U
P	Global			P1 > P2	1.07	.14	.00	.72	1.53
				P1 > P3	2.12	.17	.00	1.03	1.86
				P2 > P3	.38	.13	.01	.67	.68
M	Global			FTF > VC	.69	.25	.01	.18	1.20
P × M	Global		P2	FTF > VC	1.08	.30	.00	.48	1.68
			P3	FTF > VC	.57	.24	.02	.09	1.06
P × M × V	Global*	P3	FTF	US > T	.88	.34	.04	.04	1.73
				US > S	1.00	.36	.02	.13	1.88

Key:

P = Interview phase, P1 = Interview phase 1 (Background questioning), P2 = Interview phase 2 (Suspicious questioning), P3 = Interview phase 3 (Accusatory questioning)

M = Modality, FtF = Face to face, VC = Videoconference

V = Veracity, T = Truth-teller, S = Sanctioned deceiver, US = Unsanctioned deceiver

* The univariate test did not find a significant 3-way interaction

ones in both phase 2, $p = .001$ and phase 3, $p = .022$, suggesting that the VC dyads were unable to maintain synchrony during the suspicious and accusatory phases of the interview. These findings support H1, because synchrony was disrupted in VC compared to FtF, and H3, because the type of questioning affected synchrony. The interviewers also reacted differently across the phases of the interview. Interviewer 2 was rated by the coders as the most synchronized with her interviewees compared to the other interviewers in interview phase 1 (see Fig. 2) but that difference became less pronounced in the other two phases.[3]

H2 tested whether synchrony would be affected by veracity. Although the multivariate effects reported above for the Phase × Veracity Wilks' $\Lambda = .95$, $F(4, 124) = .71$, $p = .58$, $\eta^2 = .02$ and the Phase × Veracity × Modality interactions Wilks' $\Lambda = .94$,

[3] It should be noted that interviewer effects were controlled in all subsequent analyses but, due to space considerations, are not reported here.

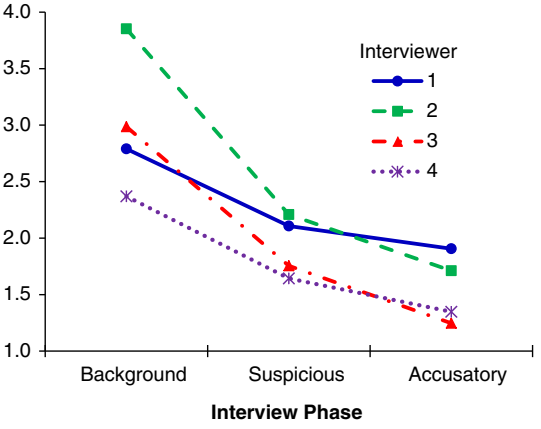

Fig. 2 Interviewer main effects for global synchrony across interview phases

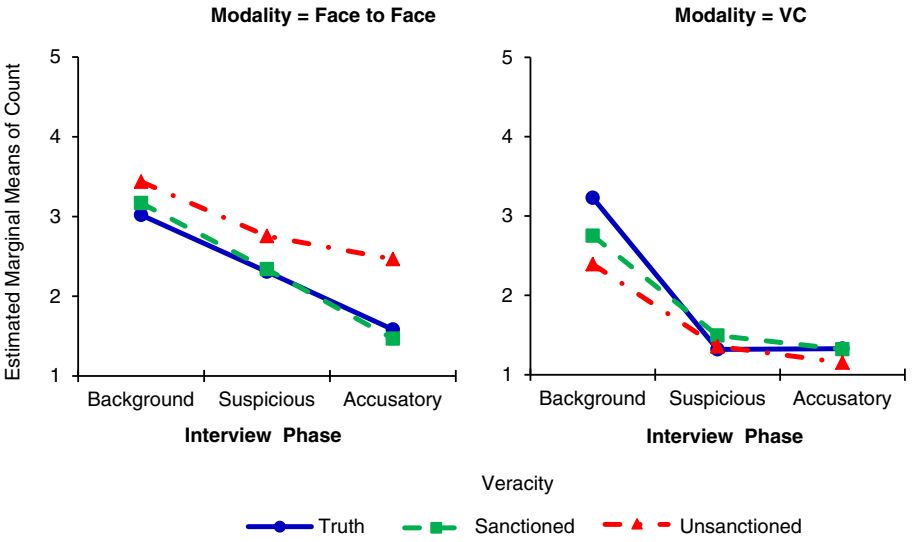

Fig. 3 Interaction effect between modality and veracity condition for global synchrony across interview phases

$F(4, 124) = .94$, $p = .44$, $\eta^2 = .03$ were not significant, a close look at Fig. 3 revealed stark differences between the two modalities for the unsanctioned group, $M_{diff} = .1.314$, $p = .022$, 95 % CI (.192, 2.436). Bonferroni-corrected comparisons indicated that in the FtF modality, the unsanctioned group maintained the most synchrony, especially during phase 3, where they differed significantly from dyads with a truth-teller, $M_{diff} = .88$, $p = .04$, 95 % CI (.04, 1.73) or a sanctioned deceiver, $M_{diff} = 1.00$, $p = .02$, 95 % CI (.13, 1.87). There were no significant differences among the groups in the VC modality. Although these results should be interpreted with caution, it appears that FtF unsanctioned deceivers may have strategically attempted to maintain high synchrony in order to appear credible, but VC unsanctioned deceivers did not. The results offer limited support for H2 because dyads with unsanctioned deceivers tended to have higher levels of synchrony than

dyads with truthful participants or sanctioned deceivers, but only in the FtF modality during the accusatory phase of questioning.

Local Synchrony

Four dependent measures of local synchrony (lower face, upper face, nodding and shaking, and laughing along) were included in a multivariate analysis of covariance with three between-subjects independent variables (modality, veracity, and interviewer) and one within-subjects independent variable (interview phase) and interview duration as a covariate. The MANCOVA on the four transformed head and face features showed a significant result in Bartlett's test of sphericity, χ^2 (9, $N = 74$) = 60.95, $p < .001$, supporting our use of MANCOVA. To protect against unequal variance–covariance matrices of the dependent variables, we used Pillai's trace in assessing multivariate effects (Meyers et al. 2006). Significant main effects were found for phase, $p = .001$, $\eta^2 = .36$, interviewer, $p < .001$, $\eta^2 = .17$, and the Phase × Interviewer interaction, $p = .011$, $\eta^2 = .20$. The main effect of modality produced a near-significant effect, $p = .063$, $\eta^2 = .13$, as did the interaction for Phase × Modality × Veracity, $p = .074$, $\eta^2 = .18$. Follow-up univariate tests were performed for each head and face synchrony feature. The results of the MANCOVA and the ANCOVAs can be found in Table 7. Table 8 presents a summary of all the significant Bonferroni-adjusted pairwise comparisons for each of the local measures of synchrony.

For lower face movements, the univariate test revealed a significant main effect for phase, $p = .003$, $\eta^2 = .17$ a significant Phase × Interviewer interaction, $p = .018$, $\eta^2 = .113$, and a significant Phase × Modality × Veracity interaction, $p = .05$, $\eta^2 = .07$. The within-subjects contrasts revealed a significant linear relationship for the interview phase, $F(1, 64) = 13.37$, $p = .001$, $\eta^2 = .17$, a significant linear relationship for the Phase × Interviewer interaction, $F(3, 64) = 5.38$, $p = .002$, $\eta^2 = .20$, and a significant quadratic relationship for the Phase × Modality × Veracity interaction, $F(2, 64) = 4.55$, $p = .014$, $\eta^2 = .12$. Figure 4 reveals that synchrony of the lower face dropped dramatically for all subjects when moving from background questioning (phase 1) to the suspicion questioning (phase 2), particularly for unsanctioned and truthful VC dyads. Paired comparisons on the estimated marginal means for Phase × Modality × Veracity revealed that modality had very little impact on lower face synchrony in that the only significant difference between the FtF and VC modalities was in phase 1 for dyads with truthful participants, $M_{diff} = -.90$, $p = .053$, 95 % CI (−1.81, .011). The type of questioning did affect lower face synchrony, supporting H3, but there were few discernible patterns in terms of the impact of modality or veracity.

For upper face movements, the univariate test revealed a marginally significant effect for modality, $p = .086$, $\eta^2 = .045$, and a marginally significant Modality × Veracity interaction, $p = .092$, $\eta^2 = .072$. Bonferroni-adjusted comparisons on the estimated marginal means of Modality × Veracity indicate that the FtF and VC dyads did not differ in terms of upper face synchrony when the participant was truthful or a sanctioned liar, but dyads with an unsanctioned liar in the VC condition demonstrated significantly less synchrony than when the interview was FtF. Pairwise adjusted comparisons indicated that in the FtF condition only, dyads with unsanctioned liars were somewhat more synchronous than dyads with truth-tellers or sanctioned liars, as can be seen in Fig. 5. There were no significant differences between veracity conditions in the VC modality. Similar to the findings for global synchrony, FtF dyads with unsanctioned deceivers tended to maintain relatively high synchrony, but this was not the case for VC unsanctioned deceivers. These

Table 7 Multivariate and univariate analysis of covariance for Phase × Modality × Veracity effects for local synchrony measures

Source	Multivariate			Univariate										
				Lower face			Upper face			Laughing along			Nodding shaking		
	F^a	p	η^2	F^b	p	η^2	F^b	p	η^2	F^b	p	η^2	F^b	p	η^2
Between															
Time (T) (covariate)	4.40	.003	.22	5.70	.020	.08	.01	.93	.00	6.80	.011	.10	2.04	.158	.03
Interviewer (I)	3.14	<.001	.17	1.99	.124	.09	.33	.80	.02	4.06	.011	.16	9.55	<.001	.31
Modality (M)	2.36	.063	.13	.06	.806	.00	3.05	.09	.05	5.33	.024	.08	3.84	.054	.06
Veracity (V)	.41	.913	.03	.23	.796	.01	.53	.59	.02	1.11	.336	.03	.05	.949	.00
M × V	1.53	.152	.09	.19	.826	.01	2.47	.09	.07	3.95	.024	.11	.18	.835	.01
Within															
Phase (P)	3.98	.001	.36	6.59	.003	.17	1.43	.25	.04	1.85	.165	.06	6.33	.003	.17
P × M	1.10	.375	.13	1.04	.360	.03	.65	.52	.02	1.18	.313	.04	1.32	.274	.04
P × V	1.40	.154	.16	1.72	.151	.05	1.41	.24	.04	1.01	.405	.03	2.07	.089	.06
P × M × V	1.62	.074	.18	2.38	.055	.07	.86	.49	.03	2.87	.026	.08	.26	.900	.01
P × I	1.89	.011	.20	2.66	.018	.11	.80	.57	.04	1.20	.311	.05	1.79	.105	.08
P × T	1.93	.072	.21	.63	.535	.02	.66	.52	.02	4.57	.014	.13	2.78	.070	.08

Multivariate F ratios were generated from Pillai's statistic. Univariate within-subject F ratios utilized Wilks' Lamba. Sample ($n = 74$) includes non-confessors only

Table 8 Significant Bonferroni-corrected pairwise comparisons for local measures of synchrony

Effect	Measure			Paired comparisons	M_{diff}	*SE*	*p*	95 % CI	
								L	U
P	Lower face			P1 > P2	1.72	.17	.00	1.32	2.13
				P1 > P3	2.12	.17	.00	1.69	2.55
	Nod/shake			P1 > P2	.64	.16	.00	.25	1.03
				P1 > P3	1.00	.18	.00	.56	1.44
				P2 > P3	.36	.14	.04	.01	.71
M	Laugh			FTF > VC	.28	.12	.02	.04	.52
	Upper face			FTF > VC	.30	.17	.09	−.04	.64
	Nod/shake			FTF > VC	.52	.27	.05	−.01	1.05
M × V	Upper face		FTF	US > T	.62	.25	.05	.00	1.24
				US > S	.65	.26	.05	.01	1.29
	Laugh		FTF	S < T	−.40	.16	.05	−.81	.00
				S < US	−.58	.18	.01	−1.04	−.13
P × M × V	Lower face	P1	T	FTF > VC	−.90	.46	.05	−1.81	.01
	Upper face*	P2	FTF	US > S	.85	.33	.04	.03	1.66
		P3	FTF	US > T	.62	.24	.03	.04	1.21
				US > S	.67	.24	.02	.07	1.27
	Laugh	P1	FTF	S < T	−.69	.28	.06	−1.39	.01
				S < US	−1.34	.32	.00	−2.12	−.56
		P2	FTF	S < T	−.43	.18	.07	−.87	.02

Key:

P = Interview phase, P1 = Interview phase 1 (Background questioning), P2 = Interview phase 2 (Suspicious questioning), P3 = Interview phase 3 (Accusatory questioning)

M = Modality, FtF = Face to Face, VC = Videoconference

V = Veracity, T = Truth-teller, S = Sanctioned Deceiver, US = Unsanctioned Deceiver

* The univariate test did not find a significant 3-way interaction

findings support H2 and H3 because synchrony was related to modality and the veracity of the participant. However, H1 was not supported on upper face synchrony because there were no differences across the phases of the interview.

For laughing along with the partner, the univariate test revealed significant main effects for modality, $p = .024$, $\eta^2 = .077$, and interviewer, $p = .011$, $\eta^2 = .16$, as well as a significant Modality × Veracity interaction effect, $p = .024$, $\eta^2 = .11$, and a significant within-subject three-way interaction effect for Phase × Modality × Veracity, $p = .026$, $\eta^2 = .08$. The within-subjects contrasts revealed a significant linear relationship for the Phase × Modality × Veracity interaction, $F(2, 64) = 5.560$, $p = .006$, $\eta^2 = .15$, such that the decline in laughing along between interview phase 1 to phase 2 was greater for FtF than VC dyads and was the greatest for FTF unsanctioned deceivers (see Fig. 5). Bonferroni-adjusted comparisons on the estimated marginal means indicated that during background questioning in the FtF condition, dyads with unsanctioned deceivers and truthful participants were more likely to laugh along than sanctioned deceivers ($p < .001$, $p = .056$). When the questions signaled suspicion, dyads with truthful participants were somewhat more likely to laugh along than dyads with unsanctioned deceivers, $p = .066$.

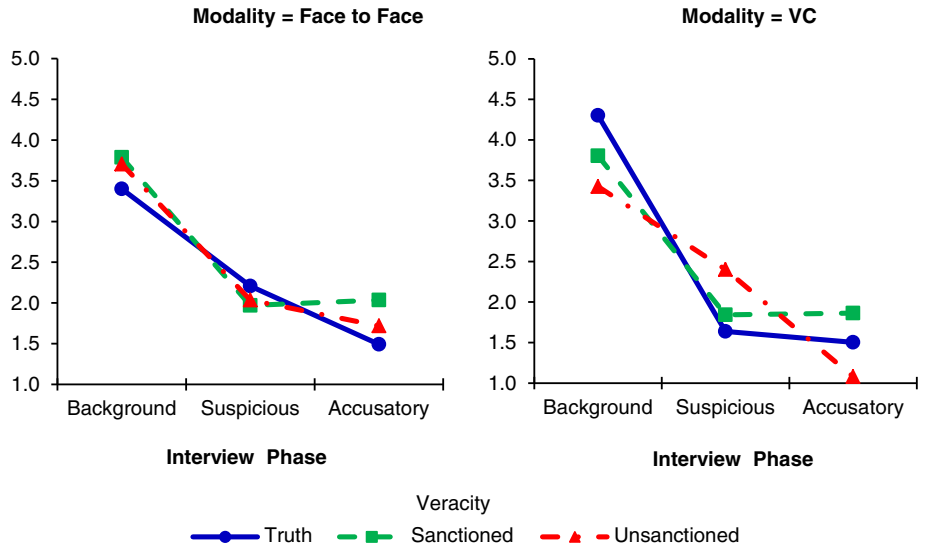

Fig. 4 Interaction effect between modality and veracity condition for lower face synchrony across interview phases

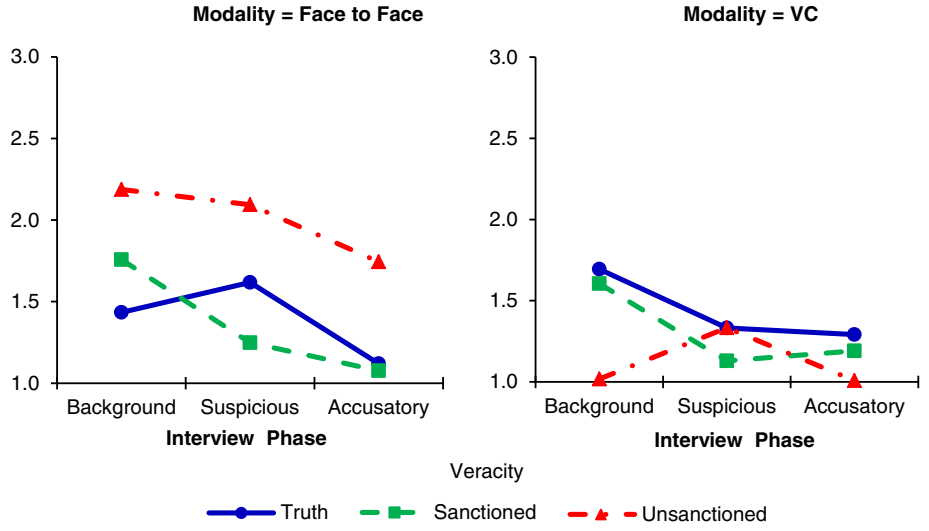

Fig. 5 Interaction effect between modality and veracity condition for upper face synchrony across interview phases

No significant differences emerged among the veracity conditions in the FtF modality during phase 3. In the VC modality, the average count of laughing along was extremely low across conditions, and truth-tellers, sanctioned liars, and unsanctioned liars did not differ significantly during any of the three phases of the interview. Again, modality had a strong impact only on unsanctioned liars, and only during background questioning. FtF

unsanctioned dyads had a relatively high rate of laughing along, but the average count of laughing along for VC dyads was very low, $M_{diff} = 1.33$, $p = .005$, 95 % CI (.428, 2.234), indicating once more that unsanctioned deceivers may have attempted to utilize synchrony as a conscious or unconscious strategy to maintain rapport and appear credible, but the VC modality was so disruptive to interactional synchrony that this was not a viable option for VC deceivers. Synchrony in terms of laughing along was related to interview phase, modality, and veracity, thus H1, H2, and H3 received partial support (see Fig. 6).

For head nodding and shaking, the univariate test revealed significant main effects for phase, $p = .003$, $\eta^2 = .17$, modality, $p = .054$, $\eta^2 = .057$, and Interviewer, $p < .001$, $\eta^2 = .309$. The within-subjects contrasts revealed a significant linear relationship for the interview phase, $F(1, 64) = 12.86$ $p = .001$, $\eta^2 = .17$, a significant quadratic relationship for Phase × Veracity, $F(2, 64) = 3.30$, $p = .043$, $\eta^2 = .093$, and a significant linear relationship for the Phase × Interviewer interaction, $F(3, 64) = 3.403$, $p = .023$, $\eta^2 = .138$. FtF dyads tended to synchronize more than VC dyads, regardless of phase or veracity. Examination of the estimated marginal means for Phase × Veracity revealed that dyads with truth-tellers, who tended to have high synchrony during background questioning, experienced a significant decrease in synchrony when the questions signaled suspicion, $p < .001$, but synchrony in phase 1 was not significantly different from phase 2 for dyads with sanctioned deceivers, $p = .38$, or unsanctioned deceivers, $p = .71$. The effect of modality was significant, lending support to H1, and H2 and H3 received partial support; type of questioning and veracity impacted the tendency to nod along.

Analyses of Relationship Between Synchrony and Confessions (R1)

Global Synchrony

The research question, which examined whether synchrony would be related to participant confession, was first tested with a mixed model ANOVA on the global synchrony ratings

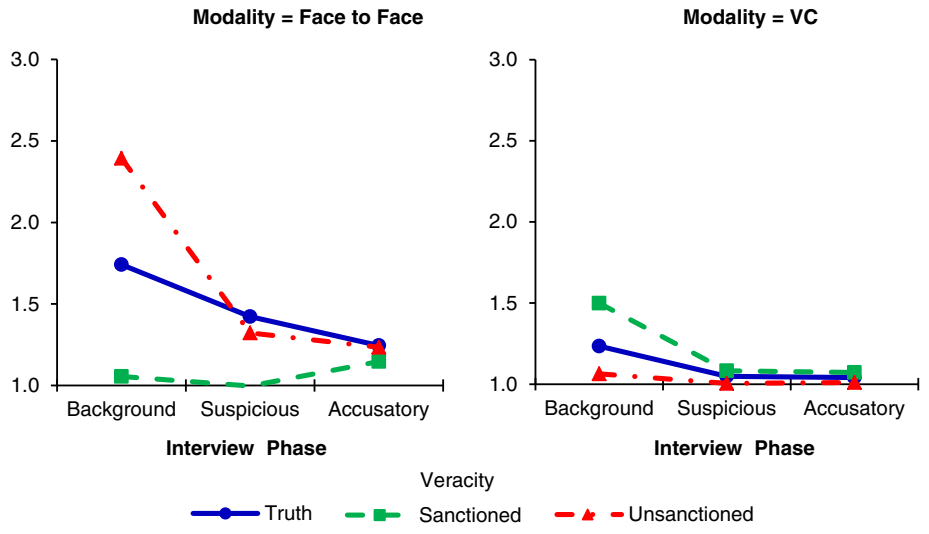

Fig. 6 Interaction effect between modality and veracity condition for laughing along across interview phases

Table 9 Mixed model analysis of variance for Phase × Modality × Confession effects for global synchrony

Source	Value	df_1	df_2	F	p	η^2
Between						
Interviewer (I)	.91	3	60	.32	.814	.02
Modality (M)	57.85	1	60	20.21	.000	.25
Confession (C)	2.30	1	60	.80	.374	.01
M × C	4.03	1	60	1.41	.240	.02
Within						
Phase (P)	.38	2	59	48.33	.000	.62
P × M	1.00	2	59	.11	.892	.00
P × C	.92	2	59	2.49	.091	.08
P × M × C	.95	2	59	1.52	.227	.05
P × I	.77	6	118	2.73	.016	.12

Within-Subjects F ratios are Wilk's approximation of F. Sample ($n = 69$) includes deceivers (sanctioned and unsanctioned) only

across the three interview phases. Modality (FtF/VC), whether or not the participant confessed (yes/no), and the interviewer ID (1–4) were included as between-subjects factors. Since no truth-tellers falsely confessed, we eliminated truth-tellers, which left a relatively small sample ($n = 69$) for this analysis. The results are presented in Table 9. Main effects were found for phase $p < .001$, $\eta^2 = .62$, and modality, $p < .001$, $\eta^2 = .25$, and there was a marginally significant interaction effect for Phase × Confession, $p = .091$, $\eta^2 = .08$. In answer to the research question, the linear within subjects effect for Phase × Confession was marginally significant, $F(1, 60) = 3.058$, $p = .085$, $\eta^2 = .05$. As is evident in Fig. 7 during the first two phases of the interview (background and suspicious questioning), the confessors and non-confessors were identical in their ratings of global synchrony. During phase 3, when most confessions actually occurred, dyads with confessors were rated as more synchronous than dyads without confessors ($M_{diff} = .58$, $p = .04$, 95 % CI (.027, 1.13). Pairwise comparisons of interview phase by confession were conducted for each modality. As indicated by Fig. 7, dyads with a confessor exhibited greater synchrony than dyads with a non-confessor during phase 3 in the FtF modality, $M_{diff} = .97$, $p = .01$, 95 % CI (.24, 1.71), but there were no significant differences for VC dyads $M_{diff} = .19$, $p = .65$, 95 % CI (−.62, .98). Skilled interviewers typically tend to use synchrony and rapport to encourage trust and cooperation with a subject, often with the goal of eliciting a confession. These findings suggest that interviewers who attempt to conduct interviews using videoconferencing may be less able to utilize such techniques.

Local Synchrony

The relationship between synchrony and confession on the four head and face features (lower and upper face movement, laughing along and nodding/shaking) was tested with a mixed model MANCOVA, with the three phases of the interview as the within-subject factor and modality (FtF/VC), report of confession (yes/no) and interviewer as between-subject factors, with duration included as a covariate. Bartlett's test of sphericity, χ^2 (9, $N = 69$) = 51.613, $p < .001$, indicated the features were related and that MANCOVA was

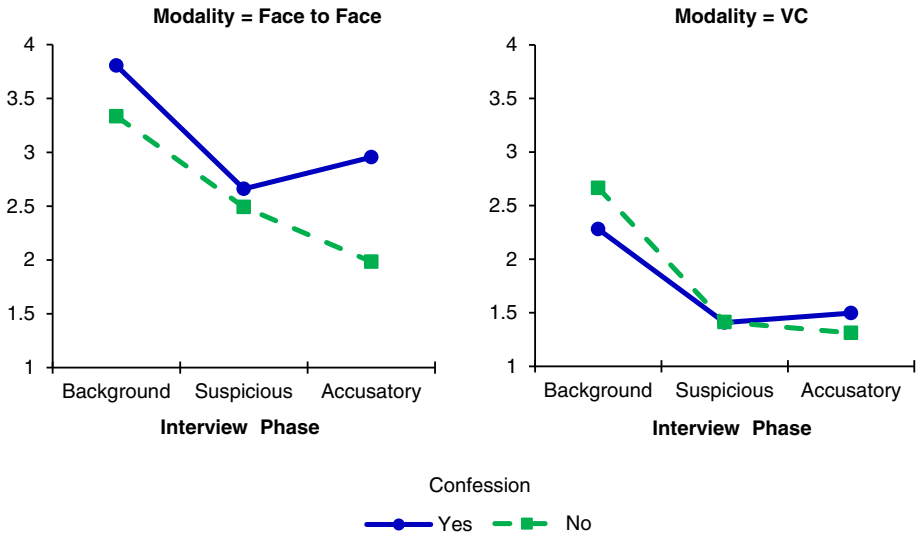

Fig. 7 Mean rating of global synchrony for confessors and non-confessors across interview phases by modality

warranted. The results did not reveal a significant between-subjects multivariate effect for the factor of interest, confession, Pillai's Trace = .05, $F(4, 58) = .73$, $p = .58$, $\eta^2 = .05$, nor were there any interaction effects for confession. Although the raters who judged global synchrony did see some increased synchronization between dyads with confessors, differences between confessors and non-confessors were not evident from these particular features.

Discussion

This study is one of the first of its kind to investigate synchrony as a method of deception detection and to examine the effects of synchrony across two different modalities, FtF and VC. We predicted that any mediation, even a rich format like VC, would disrupt the normal synchronization processes that occur during the flow of conversation. We also predicted that deception and the accusatory nature of the questions would disrupt synchrony. We found substantial support for these predictions.

The first hypothesis predicted that modality would hamper the exchange between interviewer and interviewee. In support of H1, a main effect for modality was found for global synchrony, and for the local measures of upper face, laughing along, and nodding and shaking. Synchrony in the lower face was also affected by modality, as evidenced by the Phase × Modality × Veracity interaction. Figure 8 depicts these effects among dyads with non-confessors. Interactional synchrony was dampened under VC as compared to FtF communication.

Additionally, interaction effects emerged that lend support to H2 and H3, that synchrony is affected by deception and type of questioning. The impact of modality across measures is consistent with past research that showed a degradation in social presence when exchanges are mediated (e.g., Biocca et al. 2003) even though, aside from rare

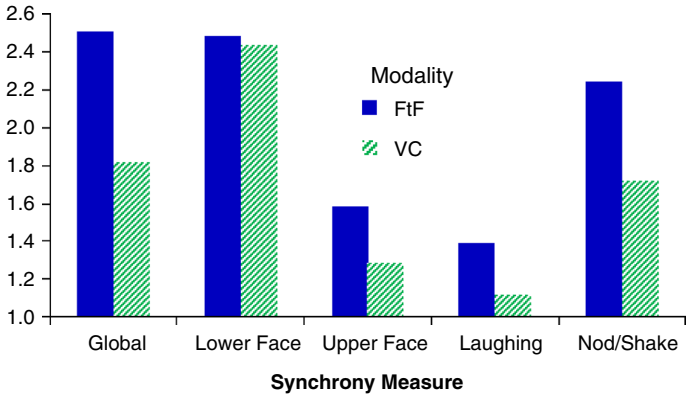

Fig. 8 Overall effect of modality for all measures of synchrony. The means of global synchrony are based on the 1–7 Likert scale ratings. The means for the four measures of local synchrony are based on counts (transformed). For each measure, a score of 1 is a rating of no synchrony or zero counts of synchrony

connectivity problems, the interviewers and interviewees had no trouble interacting through VC during the interviews.

The results imply that the effectiveness of interviewing via VC can be hindered by the modality itself. VC participants showed reduced ability to synchronize with one another overall as seen in the global ratings and especially in the more difficult latter phases of the interview. In particular, VC participants were less synchronized in their upper face movements, they showed less mirroring of one another's nodding and head shaking, and they laughed along with one another less often. Inasmuch as laughing along with one another is an important method of establishing rapport and a sense of togetherness in conflict discussions (Dunbar et al. 2012), the VC modality can be seen as restricting the nonverbal tools of which participants can avail themselves to create the enmeshment that facilitates interpersonal interactions. Although the lack of synchrony in visual cues might be attributed to difficulties with the medium's interface, the fact that the VC participants engaged in less laughing along with one another, which is both a verbal and auditory cue, suggests that the nature of conversations in VC is fundamentally different than that conducted FtF. The fact that the VC interviews were also slightly shorter than FtF (Dunbar et al. 2013) suggests a greater seriousness and task-focus in the mediated setting, although more research is needed to verify this speculation. When coupled with the results that interviewers were less able to garner confessions in the VC medium compared to FtF, the medium seemed to present a formidable barrier to the interviewers employing rapport as a method of deception detection.

The effects of modality also were apparent when examining the disruption caused to synchrony over time when questioning proceeded from the innocuous to the more suspicion-signaling inquiry of phase 2 and the outright accusations of phase 3. Supporting H3, a main effect or an interaction effect involving interview phase was found for all measures except upper face. In general, charged questions had a more disruptive impact on interactional matching and synchrony when interviews took place in a mediated fashion than in a FtF one. Thus, in addition to the powerful effect rendered by the changes in question tone from phase 1 to phase 2 to phase 3, which was disruptive in its own right, modality also exerted influence. The suspicious questioning of the second phase of the interview severely disrupted the synchrony of the VC dyads, such that the majority were rated as having very

little to no synchrony. Those in the FtF modality were better able to maintain synchrony than those in the VC modality, but showed a steady decline across the three interview phases.

Modality also played an important role in the ability to use synchrony to distinguish between truth-tellers and deceivers in that significant differences were discernible only in the FtF modality. In the global coding of synchrony, unsanctioned deceivers capitalized upon interactional adaptation to evade detection during the last block of questions by being even more synchronized than truth-tellers. No such differences were found under VC. Similarly, in the FtF modality only, dyads with unsanctioned liars tended to exhibit more upper face synchrony than truth-tellers or sanctioned liars, particularly in the third phase of the interview. Again, there were no significant differences between the VC dyads, so one might surmise that FtF deceivers who cheated and voluntarily lied tended to synchronize with the interviewer, perhaps as a means to appear credible, whereas truthful participants and those whose deceit came with the stamp of approval from the research assistant showed less synchrony, particularly when the questioning became accusatory. If deception can be reliably linked to changes in synchrony, the investigator's ability to detect this potential shift would be weakened by mediated interviews.

In addition to the modality and the sanctioning of the deception, two other variables proved to be influential: the interviewer and the interview phase. We focus on these variables because if synchrony is to be useful in distinguishing between truth and deception, it is critical to understand what else affects synchrony aside from deception. When the interviewers asked suspicious and accusatory questions, the synchrony between the interviewer and the interviewee dropped precipitously. This was the case for truth-tellers as well as deceivers and is evident in Figs. 1, 3, and 4. There was also significant variation among the interviewers as some interviewers demonstrated higher synchrony than others. We statistically controlled for these variables and their effects on synchrony in this analysis and as a result, could clearly observe the relationships among modality, deception, and synchrony. However, we believe that without this control, there is danger in misattribution of changes in synchrony. Therefore we recommend caution when relying on synchrony to identify deception because the largest and most noticeable changes in synchrony between subjects were due to variables other than deception. In addition, a control condition in which innocuous questions are discussed for the entire time period would help determine if the drop in synchrony is due largely to the change in question type, or the length of time of the conversations, or both.

Our analyses of the research question revealed that synchrony was positively related to confessions. The evidence for this finding was apparent with the global ratings of synchrony but not for the measures of local synchrony. Although the patterns for confessors and non-confessors across interview phases were similar in VC and FtF modalities, synchrony was related to the possibility of confession when the interview was conducted in person, but not for VC interviews. The finding of a relationship between synchrony and confessions is consistent with practitioner observations and recommendations. It suggests that one of the greatest benefits of synchrony is that it contributes to an environment where a deceiver feels comfortable confessing and that once the subject does confess, the interview can return to a more "normal" conversational state. Popular interviewing guides (e.g., Inbau et al. 2013) suggest that the primary objective of an interview is to create conditions under which the subject is encouraged to reveal the truth. Although additional research is necessary because our analyses do not offer a causal connection between synchrony and confession, we offer the first step in determining whether interrogators can use interactional synchrony as a tool by suggesting the link between synchrony and

confessions is real. Inasmuch as the interviewer is responsible for managing the interaction, the interviewer has a great degree of control over the level of synchrony and can alter it as he or she sees fit. The interviewer can mirror the behaviors of the interviewee or can tailor questioning to elevate synchrony, all with the hope of encouraging confessions, but, compared to an in-person interview, the VC interviewer suffers a disadvantage in terms of utilizing this influence.

Limitations and Future Directions

There are several important limitations to consider when interpreting and applying this research. First, although we used professional interviewers to increase the level of ecological validity, there were only four of them. Given that interviewer emerged as such an influential variable impacting synchrony, we hope to extend these findings to additional interviewers in an effort to generalize our results to a greater degree. Although many studies like ours rely on a single interviewer, future researchers might consider employing our methodology of multiple interviewers rather so that the effects of the interviewers themselves can be assessed and controlled.

Second, this investigation explored an existing dataset, and we did not manipulate the level of synchrony. Thus we cannot draw definitive conclusions about causality. This limits the applicability of our findings related to the research question since we cannot rule out the possibility that interviewees who intended to confess demonstrated more synchrony. Additional data collection where synchrony is manipulated is needed to rule out this alternative explanation and to support our promising, initial results.

Although the quality of the VC connection was generally good, it is possible that synchrony would be less disrupted by a higher quality connection medium, such as dedicated HD video conferencing. Research regarding the impact of quality differences in deception detection is called for. The continuing and rapid improvements in VC technology, as well as increased familiarity and comfort with its use, create a moving target in terms of understanding the differences between FtF and VC interactions.

Finally, our method of measuring synchrony relies on both subjective (global synchrony) and objective measures (counts of behavior). The directionality of the relationship between deception and synchrony varies according to these measurement approaches. Therefore, the conflicting findings of past synchrony research may be explained (at least in part) by complex interactions in which synchrony is a part and researchers have used differing methods of measurement.

Conclusion

This study demonstrates the utility of examining nonverbal synchrony in two different areas, in our demonstration of similarities and differences between VC and FtF communication, and in the promise that synchrony can provide one more tool in attempts to detect deception. As long as important variables such as modality, interviewer and question type are considered, synchrony may help to distinguish between truth-tellers and deceivers when interviews are conducted in person. However our results indicate that the significant benefit that comes from synchrony during interviews may not be a greater ability to detect deception, but may be in creating an environment that is conducive to confessions. In general, synchrony was disrupted in the VC modality to the extent that most of the findings

regarding the detection of deception or the relationship between synchrony and confessions did not occur with the VC dyads. This suggests that there are some negative consequences for using mediated communication to conduct law enforcement interviews.

Acknowledgments This research was funded by a grant from the Center for Information Technology Research, a National Science Foundation Industry/University Cooperative Research Center. The authors would like to thank their student research assistants, Bradley Adame, Kylie J. Harrison, Katherine M. Kelley, Lindsey Harvell, and Abigail Allums Kauffman for their assistance with the coding and data collection.

References

Antonacci, D. J., Bloch, R. M., Saeed, S. A., Yildirim, Y., & Talley, J. (2008). Empirical evidence on the use and effectiveness of telepsychiatry via videoconferencing: Implications for forensic and correctional psychiatry. *Behavioral Sciences & the Law, 26*(3), 253–269.

Biocca, F., Harms, C., & Burgoon, J. K. (2003). Toward a more robust theory and measure of social presence: Review and suggested criteria. *Presence: Teleoperators & Virtual Environments, 12*(5), 456–480. doi:10.1162/105474603322761270.

Burgoon, J. K., Dunbar, N. E., & White, C. (in press). Interpersonal adaptation. In C. R. Berger (Ed.), *Interpersonal communication: Handbook of communication science*. Berlin: De Gruyter Mouton.

Burgoon, J. K., Stern, L. A., & Dillman, L. (1995). *Interpersonal adaptation: Dyadic interaction patterns*. New York: Cambridge University Press.

Cappella, J. N. (1990). The method of proof by example in interaction analysis. *Communication Monographs, 57*, 236–242.

Cappella, J. N. (1991). Mutual adaptation and relativity of measurement. In B. Montgomery & S. Duck (Eds.), *Studying interpersonal interaction* (pp. 103–117). New York: Guilford.

Cappella, J. N. (1997a). Behavioral and judged coordination in adult informal social interactions: Vocal and kinesic indicators. *Journal of Personality and Social Psychology, 72*, 119–131. doi:10.1037/0022-3514.72.1.119.

Cappella, J. N. (1997b). The development of theory about automated patterns of face-to-face human interaction. In G. Philipsen & T. L. Albrecht (Eds.), *Developing communication theories* (pp. 57–83). Albany: State University of New York Press.

Davies, M. (2007). Bypassing the Hague evidence convention: Private international law implications of the use of video and audio conferencing technology in transnational litigation. *The American Journal of Comparative Law, 55*, 205–237.

Dunbar, N. E., Banas, J. A., Rodriguez, D., Liu, S.-J., & Abra, G. (2012). Humor use in power-differentiated interactions. *Humor: International Journal of Humor Research, 24*(4), 469–489. doi:10.1515/humor-2012-0025.

Dunbar, N. E., Jensen, M. L., Kelley, K. M., Robertson, K. J., Bernard, D. R., Adame, B. J., et al. (2013). Effects of veracity, modality and sanctioning on credibility assessment during mediated and unmediated interviews. *Communication Research*. doi:10.1177/0093650213480175.

Freeman, M. F., & Tukey, J. W. (1950). Transformations related to the angular and the square root. *The Annals of Mathematical Statistics, 21*(4), 607–611.

Fuller, R. M., & Dennis, A. R. (2009). Does fit matter? The impact of task-technology fit and appropriation on team performance in repeated tasks. *Information Systems Research, 20*(1), 2–17.

Gallois, C., Ogay, T., & Giles, H. (2005). Communication accommodation theory: A look back and a look ahead. In W. B. Gudykunst (Ed.), *Theorizing about intercultural communication* (pp. 121–148). Thousand Oaks, CA: Sage.

Giles, H. (2008). Communication accommodation theory. In L. A. Baxter & D. O. Braithewaite (Eds.), *Engaging theories in interpersonal communication: Multiple perspectives* (pp. 161–173). Thousand Oaks, CA: Sage.

Gouldner, A. W. (1960). The norm of reciprocity: A preliminary statement. *American Sociological Review, 25*, 161–178.

Inbau, F., Reid, J., Buckley, J., & Jayne, B. (2013). *Criminal interrogation and confessions* (5th ed.). Burlington, MA: Jones & Bartlett Learning.

Kleinman, S. M. (2006). KUBARK counterintelligence interrogation review: Observations of an interrogator. lessons learned and avenues for further research. In R. Swensen (Ed.), Educing information: interrogation–science and art. (Vol. Phase 1 Report, pp. 95–113). Washington, DC: NDIC Press.

Lawson, T., & Comber, C. (2010). Videoconferencing in English schools: One technology, many pedagogies? *Technology, Pedagogy and Education, 19*(3), 315–326.

Levenson, R. W. (1996). Biological substrates of empathy and facial modulation of emotion: Two facets of the scientific legacy of John Lanzetta. *Motivation and Emotion, 20*(3), 185–204.

Levine, T. R., Kim, R. K., Park, H. S., & Hughes, M. (2006). Deception detection accuracy is a predictable linear function of message veracity base-rate: A formal test of Park and Levine's probability model. *Communication Monographs, 73*(3), 243–260. doi:10.1080/03637750600873736.

Levine, T. R., Shaw, A., & Shulman, H. C. (2010). Increasing deception detection accuracy with strategic questioning. *Human Communication Research, 36*(2), 216–231.

Lewis, D., Tranter, G., & Axford, A. T. (2009). Use of videoconferencing in Wales to reduce carbon dioxide emissions, travel costs and time. *Journal of Telemedicine and Telecare, 15*(3), 137–138.

Lowden, R. J., & Hostetter, C. (2012). Access, utility, imperfection: The impact of videoconferencing on perceptions of social presence. *Computers in Human Behavior, 28*, 377–383.

McHenry, L., & Bozik, M. (1995). Communicating at a distance: A study of interaction in a distance education classroom. *Communication Education, 44*(4), 362–371.

Meservy, T. O. (2010). CBAS 2.0: software tools to code human nonverbal behavior. Paper presented at the Center for Identification Technology Research spring conference, Skaneateles Falls, NY.

Meyers, L. S., Gamst, G., & Guarino, A. J. (2006). *Applied multivariate research: Design and interpretation*. Thousand Oaks, CA: Sage.

Roberts, D., Wolff, R., Rae, J., Steed, A., Aspin, R., McIntyre, M., et al. (2009). *Communicating eye-gaze across a distance: Comparing an eye-gaze enabled immersive collaborative virtual environment, aligned video conferencing, and being together.* Paper presented at the IEEE virtual reality conference, Lafayette, LA. doi:10.1109/VR.2009.4811013.

Snedecor, G. W., & Cochran, W. G. (1980). *Statistical methods* (7th ed.). Ames IA: Iowa State University Press.

Taylor, T. (2011). Video conferencing vs talking face-to-face: Is video suitable for supportive dialogue? *International Journal of Therapy and Rehabilitation, 18*(7), 392–403.

Vrij, A., Mann, S., Kristen, S., & Fisher, R. P. (2007). Cues to deception and ability to detect lies as a function of police interview styles. *Law and Human Behavior, 31*(5), 499–518.

Walther, J. B. (2011). Visual cues in computer-mediated communication: Sometimes less is more. In A. Kappas & N. C. Krämer (Eds.), *Face-to-face communication over the internet: Emotions in a web of culture, language, and technology* (pp. 17–38). Cambridge: Cambridge University Press.

Warmelink, L., Vrij, A., Mann, S., Jundi, S., & Granhag, P. A. (2012). The effect of question expectedness and experience on lying about intentions. *Acta Psychologica, 141*(2), 178–183. doi:10.1016/j.actpsy.2012.07.011.

Warmelink, L., Vrij, A., Mann, S., Leal, S., & Poletiek, F. H. (2013). The effects of unexpected questions on detecting familiar and unfamiliar lies. *Psychiatry, Psychology and Law, 20*(1), 29–35. doi:10.1080/13218719.2011.619058.

Webster, J. (1998). Desktop videoconferencing: Experiences of complete users, wary users, and non-users. *MIS Quarterly, 22*(3), 257–286.