The Effect of Synchrony of Happiness on Facial Expression of Negative Emotion when Lying

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Studies have argued that emotions are often small or insignificant predictors of deception (e.g., DePaulo et al., 2003). One criticism of the negative result suggests that individuals must be engaged with each other in higher stake situations for such negative emotions to manifest (Frank & Svetieva, 2012). This study examined behavioral synchrony as a marker of engagement in a higher stakes truthful and deceptive interactions, and then compared the differences in negative emotion including fear, contempt, disgust, anger, and sadness between truth and lies. Forty-eight pairs of participants were randomly assigned to interviewer and interviewee, and the interviewee was assigned to steal either a watch or a ring and to lie about the item they stole, and tell the truth about the other, under conditions of higher stakes of up to $30 rewards for successful deception, and $0 plus having to write a 15-minute essay for unsuccessful deception. The interviews were coded for expression of emotions using EMFACS (Friesen & Ekman, 1984) by two experts certified in the Facial Action Coding System (Ekman & Friesen, 1978). Synchrony was demonstrated by the pairs of participants expressing overlapping instances of happiness (AU6+12). A 3 x 2 mixed-design ANOVA was calculated to examine the effects of synchrony of happiness (low, medium, high) and veracity (truth, lie) and found that negative facial expressions of emotion were a significant predictor of deception, but only in the medium and high synchrony conditions. This suggests that interviewer-interviewees who build rapport and are engaged with each other are more likely to create an interpersonal situation where facial expressions of contempt, disgust, fear, and sadness will predict deception. This finding is consistent with data and theorizing that shows that with higher stakes, or with higher engagement, emotions can be a predictor of deception (Ekman, 2009; Frank & Svetieva, 2013).

Introduction

There are a number of recurring controversies in the deception literature considering behavioral clues to deception (e.g., Vrij, 2008). Meta analytic studies have shown many of these clues have small effect sizes at best, which in turn has been interpreted to mean that these clues have limited to no practical utility (e.g., DeNault, et al., 2020; DePaulo, et al., 2003; Hartwig & Bond, 2011; Patterson, Fridlund, & Crivelli, 2023; Sporer & Schwandt, 2007). Other reviews have argued that it is only the nonverbal clues that are inefficient or weak indicators of deceit, and that verbal clues hold more promise (Vrij, Granhag, Ashkenazi, Ganis, Leal, & Fisher, 2022).

One subset of nonverbal clues relevant to deception are those generated by the emotions, manifested in the voice tone (e.g., Scherer, Feldstein, Bond, & Rosenthal, 1985; Streeter, Krauss, Geller, Olson, & Apple, 1977) and in the facial expression (e.g., Ekman, Friesen, & O'Sullivan, 1988). The rationale for looking for facial expression clues to deceit was based on Darwin's theorizing about the universality of facial expressions of emotion (Darwin, 1872/1998; Ekman 1985/2009). Darwin argued that human emotions evolved to reorganize the body's physiological priorities to facilitate the action tendencies of each specific emotion (Frijda, 1986; 2010), such as escape in fear, or attack in anger, and so forth. He further argued that as social creatures, humans must then communicate their intentions toward these actions in order to smooth social interactions and reduce conflict, and proposed that humans (and the great apes) signal these emotional states such as anger, contempt, disgust, fear, happiness, sadness, and surprise primarily through the facial expression (Ekman, 2007). These emotional facial expressions are part of the emotional reaction, and driven by 'nerve force" onto the face, which meant they were involuntary and hence difficult to inhibit (Darwin, 1998; Ekman & Friesen, 1969; Hurley & Frank, 2011; Porter & ten Brinke, 2008; ten Brinke, Porter, & Baker, 2012). Therefore, if a lie

triggers an emotion (e.g., fear of getting caught), this reaction produces an emotional facial expression which may 'leak' upon the face, even despite efforts to conceal it (Ekman & Friesen, 1969). This meant that to the extent a liar experiences a particular emotion when they tell a lie, is the extent to which signs of that emotion in the face (or voice) may appear and betray the liar (Ekman, 1985/2009; Frank & Ekman, 1997).

The logic then follows that liars who are motivated not to get caught will attempt to suppress their emotional reactions to lying; these efforts often result in the emotional expression appearing on the race for only 500ms or less (which is what is now called a micro expression; Ekman & Friesen, 1969; Haggard & Isaacs, 1966). Besides suppression, these facial signs of emotion can also be masked or concealed by other expressions such as smiling; these 'masking' smiles often contain traces of other negative emotional expressions of fear, sadness, disgust, or anger that can betray deception (Ekman, 1985/2009). This phenomenon has been documented in both the laboratory (Ekman, et al., 1988) as well as real life situations involving false innocence pleas by murders (ten Brinke, et al., 2012).

One criticism for the finding of facial expressions of emotion as clues to deceit was that the facial expressions of emotion associated with the lie was not generated by telling a lie, but instead caused by the distressing stimulus material which was falsely described as pleasant. The early studies consisted of participants first viewing a film of pleasant ocean waves and honestly describing it; then second viewing a graphic film of a leg amputation and lying about it by claiming it was another ocean waves film (Ekman & Friesen, 1974). This film viewing paradigm confounded order – truth always came first - and type of film watched for truth and lie. Therefore, the negative facial expressions of emotions generated by the liars in this paradigm could be reasonably attributed to participant's reaction to the amputation film, and not to the act

of lying (Kraut & Poe, 1980). This deception paradigm had the potential effect of overestimating the strength of facial expression clues of emotion as a reliable indicator of deception.

This criticism led scientists to make a distinction between 'lying about feelings' (as these original participants did by hiding their distress and disgust and claiming they felt pleasant) and 'feelings about lying' (the emotions generated by lying itself; Ekman, 1985/2009). Since then most deception research focused on deception paradigms designed to examine 'feelings about lying.' These paradigms include scenarios such as lying about a mock theft, or about an opinion, or one's performance on a task (see Frank, 2005, for a review). These paradigms removed the confounds of the film viewing paradigm, yet still have been shown to generate a higher rate of facial expressions of negative emotion in the liars than truthtellers - but only in scenarios where the stakes for unsuccessful deception are high (Frank & Ekman, 1997; 2004; Matsumoto & Hwang, 2018a; 2018b; 2021; Porter & ten Brinke, 2008; Shen, Fan, Niu, & Chen, 2021, ten Brinke & Porter, 2012; ten Brinke, et al., 2012).

These facial expressions of negative emotion have not appeared in the most comprehensive meta-analyses on behavioral clues to deception (DePaulo et al., 2003; Hartwig & Bond, 2011; Sporer & Schwandt, 2007). Positive emotion, expressed via smiling, has appeared and had been shown to reliably decrease when someone was lying (DePaulo et al 2003; Sporer & Schwandt, 2007). The only other facial expression behaviors to appear in the meta analyses were more gross movements of facial pleasantness, and general facial expressiveness, both of which decreased with deception (Hartwig & Bond, 2011). Notably, there were no entries in the meta analyses at the level of specific negative emotions such as facial expressions of anger, contempt, disgust, fear, and sadness.

There are two reasons why these particular expressions were not included in these meta analyses. The first, of course, is that many of the studies that documented the relationship between facial expressions of emotion and deception were published after the publication of the meta analyses. But the second, and more significant reason, is that there were only a handful of studies that actually coded both macro and micro facial expressions of emotion to determine their relationship to telling lies (Frank & Ekman, 2004; Frank & Svetieva, 2012; Matsumoto & Hwang, 2018a,2018b; 2021; Porter & ten Brinke, 2008; Shen et al. 2021; ten Brinke & Porter, 2012; ten Brinke, et al. 2012). The limited number of such studies may account for why there was significant pushback on the utility of micro expressions of emotion as a behavioral clue to deception (Burgoon, 2018), and why scientists would dismiss the leakage of these emotional clues as being "…undefined. The (unspecified) cue could literally be any behavior." (Vrij, et al., 2022, p. 3). This also accounts for why some scholars have argued that any use of these behaviors (amongst others) to detect terrorists in airport security situations is so weak as to be considered pseudoscience (Denault, et al., 2020).

Upon closer examination we note three issues that may inform this debate. First, even within these meta analyses, moderator analyses show that emotion-based behavioral clues have higher effect sizes when the participant (the liar) has higher motivation (hence more likely causing an emotional reaction within the participant; e.g., DePaulo et al, 2003, reviewed by Frank & Svetieva, 2012; Frank & Svetieva, 2013; Sporer & Schwandt, 2007). Second, in order to trigger facial expressions of emotion, one must employ high stake paradigms in the laboratory or from real world situations, and the majority of published studies on deception have not done so (see Frank, 2005, for a review). Third, these facial expressions were simply tabulated when individuals lie or tell the truth; this can be problematic as individuals often show negative

emotions when truthfully describing some aspect of narrative (e.g., a participant shows disgust when saying 'I saw that hideously ugly looking ring"). This introduces noise into the assessment as to whether these expressions can betray deception. Instead, a tighter analysis would tally only those negative emotions which are not clearly consistent with the content of the speech. These emotions discrepant with the speech content were called 'hot spots' (Ekman, 1985/2009; Frank, Yarbrough, & Ekman, 2006), or 'anomalies' (Moskal, 2013). For example, a participant who shows the facial emotion of disgust as they say "I hate that guy" is speaking words consistent with the purported emotional content of the facial expression, but a participant who shows the facial emotion of disgust as they say "I love that guy" is speaking words discrepant with the purported emotional content of the face. Coding these anomalies or hot spots required much more micro momentary analysis to identify not just the presence of the facial expressions of emotion, but to align the presence of the facial expression to the words spoken at the time of expression (regardless of the length of the particular expression). These anomalies are both macro and micro expressions (more or less than 500ms in duration, respectively), can be detected with the naked eye, and officers can be trained to detect these anomalies in real time (Matsumoto, Hwang, Skinner, & Frank, 2014).

Taken together, facial expressions of emotion seem to be discounted as a clue to deceit because studies do not offer stakes high enough to generate emotions in the liars, or studies do not code for facial expressions of emotion, or they do not examine the presence of the emotion within the context of the speech of the liars and truth tellers. This suggests that high stakes and the *intra*personal context is essential to ascertain whether negative facial expressions of emotion - such as contempt, disgust, sadness, or fear (be they micro expressions or macro expressions) - can betray deception, with the prediction that only those expressions that are discrepant with the

words spoken should be analyzed to predict deception. Note we left anger off the negative emotion list, as previous work has shown it is more likely to be expressed by truthtellers than liars (Hatz & Bourgeois, 2010).

Interpersonal engagement

We also propose a second kind of context will also affect the utility of facial expressions of emotion, and that is the *inter*personal context. This context refers to the nature of the interaction between liar and lie catcher. Of course, we recognize that the types of questions asked by the lie catcher are essential to any sort of lie detection (Colwell et al., 2007, Frank, 2005; Frank, Yarbrough, & Ekman, 2006; Levine et al, 2011; Hwang & Matsumoto, 2020; Vrij, et al., 2022), but in this case we are referring to the *style* of interaction between the liar and lie catcher. Specifically, we propose that a rapport building style of interview, which is built upon the similarity, empathy, and liking between to engaged individuals in an interaction (Bernieri, Gillis, Davis, & Grahe, 1996), would not only be more pleasant to the interviewee (e.g., Chartrand & Bargh, 1999) but it would induce the interviewee to disclose more personal information (Dianiska, Swanner, Brimbal, & Meissner, 2021; Novotny, Frank, & Grizzard, 2021). We further proposed that when in rapport, individuals tend to feel not just more pleasant but also more emotionally engaged; engagement would lower the negative emotional feelings or 'noise' caused by the investigative situation in general. Then if a negative emotion was triggered, the facial signs of that emotion would be easier to detect. In contrast, for example, if an interviewer is threatening and hostile, they might artifactually generate negative emotions (i.e., the 'Othello error", Ekman, 1985/2009) that have nothing to do with a lie or the truth, which then would confound any efforts to determine if these facial expressions can distinguish liars from truthtellers. However, if an interviewer built rapport, then by definition rapport means more

positivity in both individuals, which would reduce the chance that truth tellers would show as many negative emotions as liars.

The positivity element of rapport has shown that nonverbal signs of positive emotion reflect the presence of rapport between the interviewer and interviewee (Tickle-Degnen & Rosenthal, 1990). Moreover, these signs of rapport have been shown to synchronize between the individuals (Bernieri, 1988; Bernieri, Davis, Rosenthal, & Knee, 1994), which includes mirroring the nonverbal behaviors of each other (Chartrand & Bargh, 1999). More recent studies, using detailed computer vision and machine learning, has shown that behavioral signals of engagement and rapport can be detected by these programs at rates better than human judges (Sharma, Gangadhara, Xu, Solbu, Frank, & Nwogu; 2021). These programs superiority was based upon its superior ability to detect coordinated actions such that when in rapport the interviewer and interviewee showed similar expressions within one second of each. The most frequent expression noted was a smile, which makes sense as the smile is one of the most easily identified, as well as easily controllable, facial expression (Hager & Ekman, 1979; Fridlund, 1991; Hurley & Frank, 2011). Other computer vision based systems applied these behavioral synchrony principles directly to rapport and deception detection and found that in face to face encounters, liars were lower in rapport than truth tellers (Dunbar, Giles, Bernhold, Adams, Giles, Zamanzadeh, Gangi, Coveleski, & Fujiwara, 2020). However, in video conferencing encounters, the relationship between lying and rapport was more unclear (Dunbar, Jensen, Tower, & Burgoon, 2014). Regardless, these last two studies did report that coordination in both the upper and lower face movements between interviewer and interviewee was an important element of rapport (Dunbar, et al., 2020).

Taken together, the aforementioned rapport studies show facial coordination is an element of rapport, and in particular those signals of engagement and positivity between the interlocutors. One of the most powerful and documented signals of positive emotion (happiness), are the Duchenne smiles, which are the smiles featuring orbicularis oculi action along with zygomaticus major (Ekman & Friesen, 1982; Ekman, Davidson, & Friesen, 1990). This then suggests that the coordinated expression of Duchenne smiles – the emotion of happiness - should be a reliable marker of positivity engagement during rapport. We propose that the synchronized expression of the emotion of happiness between interviewer and interviewee would indicate engagement and involvement, and once that state is achieved, any presence of negative emotions not consistent with speech content would have a much higher chance of being caused by the act of telling a lie. We believe that strong interpersonal bonds that become violated by a lie would elicit stronger negative emotions than weak interpersonal bonds; these stronger negative emotions are then more likely to manifest themselves in the facial expression.

Overview.

To test this proposition we have to induce rapport. This may be more or less difficult to produce in a laboratory context. If friends are recruited to be the interlocutors, we presume the rapport will be easier to induce. If strangers are recruited – which is the situation that professionals, such as a law enforcement officer, might encounter – then rapport may be harder to induce (e.g., Frank et al, 2006), but not impossible. Previous work showed experimenters could build rapport with strangers who functioned as witnesses to a dramatic event (Collins, Lincoln, & Frank, 2002). This means that both friend rapport and stranger rapport situations are both ecologically valid situations.

The current study intends to combine elements of the *intra*personal and *inter*personal context to re-examine the role of negative facial expression on predicting deception such that under conditions where there is higher synchrony of the emotion of happiness, we predict that facial expressions of negative emotion will be more likely to betray a lie. To test this we adapted a variant of the mock theft paradigm and added higher stakes, then assess whether interactants build rapport with each other, and then measured the presence of negative facial expressions of emotion (of any length) within the content of speech, and within the synchrony of happiness.

Specifically:

H1a: Facial expressions of the negative emotions of contempt, disgust, sadness, and fear, as coded by the Facial Action Coding System (Ekman & Friesen, 1978), that are not consistent with the speech content, will appear more often in participants when they lie compared to when they tell the truth.

Based upon previous findings (Hatz & Bourgeois, 2010):

H1b: Facial expression of the negative emotion of anger will appear more often in participants when tell the truth compared to when they lie.

The second hypothesis involved interpersonal context. Given that engagement and involvement were the best marker of rapport (Dunbar, et al., 2020; Frank & Svetieva, 2012) and that the synchrony of the emotion of happiness seemed to drive computer vision predictions of rapport (Sharma, et al., 2021), we predict:

H2: When the synchrony of the emotion of happiness is high, compared to when it is low, the facial expressions of the negative emotions of contempt, disgust, fear, and sadness will appear more often in participants when they lie compared to when they tell the truth.

We were also curious as to the role of familiarity on the ability to build rapport, as noted earlier friends and strangers face situations where they may produce behavioral synchrony. Thus, we recruited both friends and strangers, and asked:

RQ: What is the role of familiarity on building rapport and the presence of facial expressions of emotion and deception?

Method

To analyze the synchrony of happiness and negative emotion when lying and truth telling, as well as to explore the role of familiarity, we recruited good friends and partners to be participants. We did this to avoid pro-social or affiliative confounds, and pairs of friends would be ‘split up’ to interact with persons from another dyad, to produce a 'Not Friends’ condition. Thus, when two dyads arrived to their scheduled appointment, each dyad was seated in a separate office, isolated from the rest of the experiment. One person in each dyad was randomly assigned to be the ‘interviewer’ and the other the participant interviewee. The participant interviewee from the first office was thereafter paired with the interviewer from the second office, to participate as ‘Not Friends’. The other two were asked to wait until it was their turn to participate. If only one dyad showed up to the scheduled appointment, they were run as ‘Friends’, and randomly assigned to their interviewer or interviewee role. While the participant interviewee was given the instructions to steal either the watch or ring, in a separate room, the interviewer was instructed to study the interview questions seated in the interview room.

Participants

One hundred thirty-four students from the State University of New York at Buffalo participated, resulting in 67 dyads. Nine-teen dyads were excluded from the sample due to an initial error in one of the interview questions, video quality/focus issues, or due to the

participants not following directions. This resulted in a final sample of 96 participants and 48 dyads with resulting interactions.

The randomly assigned participant interviewers were 45.8% (n = 22) female and 54.2% (n = 26) male. The participant interviewers ranged in age from 18 to 27 years (M = 19.88, SD = 1.94). Based upon self-identification, the interviewer group was 60.4% Caucasian, 16.7% Asian, 6.3% Caribbean, 4.2% African, 6.3 % Mixed, and 6.3% Other (Hispanic, Indian, Middle Eastern). 87.5% of the interviewers reported speaking English as first language.

The randomly assigned participant interviewees were 60.4% (n = 29) female and 39.6% (n = 19) male. The participant interviewees ranged in age from 18 to 25 years (M = 19.56, SD = 1.61). Based upon self-identification, this participant group was 52.1% Caucasian, 18.8 % Asian, 10.4%, African, 12.5% Mixed, and 6.3% Other (Indian, Caribbean). 85.4% of the participants reported speaking English as first language.

Gender composition of the interactions was 27.1% (n = 13) female/female, 20.8% (n = 10) male/male, 33.3% (n = 16) male (interviewer)/female (interviewee), and 18.8% (n = 9) female (interviewer)/male (interviewee). 56.3% (n = 27) of the interactions were between Friends and 43.8% (n = 21) between Not Friends.

Materials

In order to capture participants' interpersonal closeness during the interaction, we used the seven-point, single item, Inclusion-of-Other in Self (IOS; Aron, Aron, & Smollan, 1992) visual scale, which includes "self" and "partner" circles, overlapping to different degrees, ranging from no overlap to full overlap. To measure participants impression of rapport during the interaction, we employed the 18-item Rapport Questionnaire (Bernieri et al., 1994) and a 7-point

single-item synchrony rating (*How synchronized did you find the interaction*?). In order to assess participants social interaction characteristics, we used the 40 item 4-point The Empathy Quotient (EQ) (Baron-Cohen & Wheelwright, 2004; Lawrence et al., 2004) without the 20 filler items, the 15 item Emotional Contagion (EC) scale (Doherty, 1997), in addition to a 17-item emotion scale modified from Ekman & Friesen (1974). Finally, we included a question assessing how long they had known the person they interacted with, in addition to a standard demographic questionnaire.

Procedure

After entering the lab, and obtaining consent, and assigning to friends or not friends conditions, we instructed participant interviewees to go to the file room and steal either a ring or a watch (see Kircher & Raskin, 1988; Kozel, Johnson, Mu, Grenesko, Laken, & George, 2005). We asked them to hide the object somewhere in the conference room, making sure not to alert suspicion or leave any fingerprints (see Pollina et al., 2004). In order to increase the stakes of the situation (see Frank & Ekman, 1997, 2004), we explained that if they were successful at convincing the interviewer (blind to the forced choice of stealing one object) that they did not steal either object, they would receive US$30. If they were successful convincing the interviewer that they did not take the one of the objects, they would receive $20 if they had actual stolen it, or $10 if they had not stolen the object. If the interviewer did not believe them at all for both interviews, they would not receive any money and be asked to write an essay about their unsuccessful performance for the duration of 15 minutes. Similar to the incentives/punishment given to the participant interviewees, the interviewer was incentivized to perform a proper interview: $30 for excellent performance, $10 for average performance, and $0 and 15 minutes of essay writing, for poor performance and failure to follow instructions.

The interview took place in a single room office furnished with two reasonably, but not overly, comfortable chairs opposite of each other, with 2m in between. Blue drapes covered three walls, including the window, and a fourth drape was placed across the width of the room as a divider to separate the interview area from the experiment technician who recorded the interview. The interview questions were attached to a mounted clipboard, positioned front left of the interviewer, so as to not restrict hand movements or obscure the view between the participant interviewer and the participant interviewee. The interview consisted of two parts, each with four baseline questions, regarding arriving to/leaving the lab, best/worst thing that happened in the past week (counterbalanced), and the general experience in the lab and file room, followed by these ten counterbalanced ring/watch questions:

1. Did you see the [ring, watch]?
2. Could you please describe the [ring, watch] with as much detail as possible?
3. Did you take the [ring, watch]?
4. Do you have the [ring, watch] with you now?
5. Where is the [ring, watch] now?
6. Could you please explain what happened to the [ring, watch]?
7. Did you hide the [ring, watch]?
8. So what made you decide *not* to take the [ring, watch]?
9. Is everything you told me about the [ring, watch] the truth?
10. Is there anything else that you would like to add to your account?

Measures and Equipment

In total, we used five video cameras and two webcams for audio to capture the interview. Additionally, Biopac was used to measure electro dermal activity (EDA) wirelessly on both the

interviewer and participant. [Since EDA and full body video analysis is not part of the current studies, this equipment and method will not be discussed further]. The facial data and audio for the current studies was recorded using two Canon Camcorders with 1920x1080 resolution and 30 fps. The camcorders were mounted to the head part of tripods, which were fastened to shelves situated above the interviewer and interviewee, respectively. To record the facial data remotely, from behind the blue curtain room divider, we used Elgato Game Capture card and associated software.

Following the interview, we administered the Inclusion-of-Other in Self (IOS; Aron, Aron, & Smollan, 1992) scale, the Rapport Questionnaire (Bernieri et al., 1994) and a synchrony rating, the Empathy Quotient (EQ) (Baron-Cohen & Wheelwright, 2004; Lawrence et al., 2004) the Emotional Contagion (EC) scale (Doherty, 1997) and an emotion scale (Ekman & Friesen,1974). Finally, participants were also asked to indicate how long they had known the person they interacted with, in addition to fill out a standard demographic questionnaire.

Facial expressions

Video synchronization of all collected videos was completed using audio tracks to align. We engaged two experts, each certified in the FACS (Ekman & Friesen, 1978), with over 10 years of coding experience, to use Emotion FACS (EMFACS, Friesen & Ekman, 1984) guidelines to identify expressed emotion in the interviewers and interviewees (scoring agreement at .80 and higher). The codes that were recorded were the emotions, the emotion FACS codes, apex frame and intensity level. Apex is the frame with the largest change within an event (Ekman & Friesen, 1978). Onset and offset frames were not recorded since manual FACS coding is extremely time consuming and expensive, and apex coding was deemed sufficient for the purpose of the studies. Each video was coded separately.

For the participants' videos, we labeled the verbal context of each negative emotion (disgust, fear, sadness, anger, and contempt) as either 'truthful object description', 'truth', or 'lie'. In our comparison of negative emotion between truths and lies we employed truths other than descriptions to disregard emotions that were elicited as a result of describing the objects (plain ring and purple watch), which generally were perceived as ugly. All other emotions in both the truthful and deceptive interviews were left for analysis.

Instances of synchrony of happiness were counted by identifying overlap in the facial expression of happiness, guided by the EMFACS coded apex of happiness (AU6+12). Thus, if the interviewer showed happiness first, which then overlapped with the happiness of the participant interviewee, one count of synchrony was counted. If the interviewer showed another apex of happiness before the participant stopped expressing happiness, we added another count of synchrony. We applied the same logic if the participant showed happiness first. Although this type of pattern could be repeated in many iterations, yielding many counts of synchrony, there were typically times where neither the interviewer nor the participant expressed happiness, especially since the focus was on the interview about a theft. The synchrony of happiness measure did not specifically capture the intensity level of the happiness expressions; however, higher intensity happiness in both interviewer and participant would typically result in more counts of synchrony of happiness, as higher intensity of expressions typically (although not always) have longer durations (e.g., Frank, Ekman, & Friesen, 1993). This in turn would allow the other party more time to join in on the expression. Based upon count of synchrony of happiness and the pattern of the data in the interviews, we split the prevalence of synchrony of happiness data into thirds; each dyad as having either 'low' (0-7), 'medium' (8-15), or 'high' (16-higher) level of synchrony of happiness, as reflected in the overlapping enjoyment smiles.

Design

Our main independent variables are then synchrony of happiness (high, medium, low, a between subject comparison), and veracity (truth, lie, a within-subject comparison). Our main dependent variable was the summed total of each presence of a facial expression of negative emotion as scored by EMFACS. We also examined other paper and pencil measures of rapport described above to see if they could capture qualities between the interlocutors that would inform the results. We also compared whether the dyads were friends or not friends.

Results

We addressed the RQ concerning dyads that were friends compared to dyads that were not friends by comparing rates of synchrony of happiness. We found the level of synchrony of happiness was not significantly higher for interactions between friends (M = 10.63, SD = 7.31) compared to interactions between participants who were not friends (M = 10.52, SD = 6.15) F *(2, 46)* = 0.003, η^2 = .000. Moreover, participants in the friends condition (M = 12.81, SD = 7.088) did not display significantly more happiness overall than participants in the not friends condition (M = 13.86, SD = 6.988) $F(1, 46) = .26$, $p = .613$, $\eta^2 = .006$. Likewise, interviewers in the friends condition (M = 12.48, SD = 5.323) did not display significantly more happiness than interviewers in the not friends condition (M = 14.33, SD = 6.537) $F(1, 46) = 1.17$, $p = .285$, $\eta^2 = .025$. Therefore, we combined the friends and not friends samples for ensuing analyses.

A 3 x 2 mixed-design ANOVA was calculated to examine the effects of synchrony of happiness (low, medium, high) and veracity (truth, lie) on the total negative emotions minus anger, after eliminating any negative emotions shown during the description of the ring or watch. We found no main effect for the synchrony of happiness ($F(2, 25) = 2.52$, $p = .092$ $\eta^2 = .101$). We did find a significant main effect for veracity ($F(1, 45) = 12.16$, $p = .001$, $\eta^2 = .213$) such that

number of facial expressions of negative emotions for lies ($M = 4.65$, $SD = 5.18$) was higher than the number of facial expressions of negative emotion for truths ($M = 2.33$, $SD = 2.44$). This supports Hypothesis 1a.

We broke down the individual emotion expressions (see Table I). The pattern showed that the liars showed more negative emotions when lying for all the negative emotions save anger. One tailed paired t-tests showed that fear (t (47) = 3.807; $p < .001$, $d = .55$) and sadness (t (47) = 2.59; $p < .01$, $d = .37$), and disgust (t (47) = 1.89; $p = .065$; $d = .27$) significantly predicted deception. There was no significant effect for contempt (t (47) = .81, $p = .21$, *ns*.).

Although truthtellers did show more anger than liars, as predicted, this difference was not statistically significant (t (47) = -1.14, $p = .13$, *ns*.), hence disconfirming Hypothesis 1b.

In order to test Hypothesis 2, we examined the interaction of three levels of synchrony of happiness on veracity. The results are shown in Figure 1. To best assess this interaction, we subtracted the number of facial expressions of negative emotions shown by participants when they were telling the truth from when they were lying to generate a change score. We then ran a one-way ANOVA with Fisher's LSD as contrasts. We found a significant effect across of synchrony of happiness ($F(2, 45) = 3.33$, $p = .045$, $\eta^2 = .129$). Fisher's LSD revealed that the liars showed significantly more facial expressions of negative emotions in the medium synchrony ($p = .029$) and high synchrony groups ($p = .034$), but did not show any difference in the low synchrony group ($p = .775$). Therefore, facial expressions of negative emotions only differentiated the liars from the truth tellers under conditions of medium or high synchrony of happiness. When the interlocutors were not so engaged, there was no difference in the expressed negative emotion. This supports Hypothesis 2.

To further examine the utility of using negative emotions to predict deception, we calculated hit rates for predicting deception based upon which interview had more expressions of negative emotions. If the lie interview had more expressions of negative emotion than the truth interview, then it was coded as a hit. If each interview had the same amount, then it was coded as indeterminant. If the truth interview had more expressions of negative emotions, then it was coded as a miss. We then examined the hit rates for the low synchrony versus combined high and medium synchrony. We combined the latter two as their results were similar (see Figure 1). We found that under low synchrony had hit rates of 25% hits, 38% indeterminant, and 38% miss. In contrast, the combined higher synchrony had 66% hits, 16% indeterminant, and 19% miss. Thus when in synchrony the simple decision rule of more expressions of negative emotion produce accuracy as higher than human judges with the naked eye (54%; Bond & DePaulo, 2006).

Self-reported interpersonal closeness, rapport, and synchronization

Although the dyads for friends or not friends did not affect the main results, we examined some of the measures to see if they added any insights. We did find that friends in their dyads reported having known each other from 2 months to 20 years (M = 3.95, SD = 4.88, Mdn = 2 years), whereas dyads in the Not Friends condition reported having just met for the study (n = 20) or known the other person for one month (n = 1).

The single measure inclusion-of-other in self (Arnon et al, 1992) revealed, unsurprisingly, that participant interviewees in the Friends condition (M = 5.04, SD = 1.74) felt significantly closer to the interviewer than participants in the Not Friends condition (M = 1.95, SD = 1.02) F (1, 46) = 51.75, p = .000, η^2 = .529. Similarly, interviewers in the friends condition

(M = 4.96, SD = 1.83) felt significantly closer to the participant interviewees than interviewers in the not friends condition did (M = 1.90, SD = 1.04) $F(1, 46) = 46.72$, $p = .000$, $\eta^2 = .504$.

Computing the total score of the Bernieri et al. (1994) rapport questionnaire, participant in the friends condition did not reported any higher total rapport (M = 118.96, SD = 22.95) than participants in the not friends condition (M = 112.48, SD = 15.95) F (1, 46) = 1.22, $p = .276$, $\eta^2 = .026$. Similarly, interviewers in the friends condition did not report any higher total rapport (M = 116.04, SD = 18.60) than interviewers in the not friends condition (M = 114.05, SD = 17.65) F (1, 46) = .14, $p = .709$, $\eta^2 = .003$. This may be why the emotional measures analyzed earlier were not affected by the friendship status of the dyad.

For the single question "How in synch did you feel with your partner during the interaction" participant interviewees in the friends condition (M = 4.78, SD = 1.34) did not feel significantly more in synch than participant interviewees in the not friends condition (M = 4.19, SD =1.27) $F(1, 46) = 2.61$, p=.113, η^2 =.054. However, interviewers in the friends condition (M = 4.89, SD = 1.37) did feel significantly more in synch than interviewers in the not friends condition (M = 4.05, SD = 1.32) $F(1, 46) = 4.60$, p=.037, η^2 =.091.

We also examined whether empathy, another known component of rapport (Bernieri, et al. 1996), might have affected the smiling. Simple linear regression showed that synchrony of enjoyment smiles could not be predicted based on the participant's empathy scores ($F(1, 46)$ = .036, p = .850, with an R^2 of .001), nor from their emotion contagion scores ($F(1, 46) = .24$, p = .629 with an R^2 of .005).

Simple linear regression showed that synchrony of enjoyment smiles could not be predicted based on the interviewer's empathy scores either ($F(1, 46) = .011$, p = .915, with an R^2

of .000). However, synchrony of enjoyment smiles could be predicted based on the interviewer's emotion contagion score with an R^2 of .120 ($F(1, 46) = 6.26$, $p = .016$). Predicted synchrony of enjoyment smiles was equal to -8.81 plus an increase of .439 for each point of emotion contagion scored by the interviewer. Thus suggests a slightly stronger role for the interviewer in driving the synchrony.

Taken together, this meant that although participants in dyads of friends felt closer to each other, participants in the friends condition did not feel higher rapport or synchronization with their partner than in the not friends condition. However, friendship was not randomly assigned in this study thus we interpret these results with caution.

Discussion

These results provide further evidence that negative facial expressions of emotion can have utility for betraying deception (e.g., Ekman, et al., 1988; Bartlett, et al., 2014; Matsumoto & Hwang, 2018a, 2018b., 2020; Shen, et al., 2021; ten Brinke, et al., 2012). The results advanced our knowledge in two ways. First, it showed that the intrapersonal context, as reflected in emotions elicited in a high stakes deception situation that are inconsistent with the content of the speech, provide a more theoretically grounded and quantifiable measure of the role of negative emotions in deception. Second, it showed that the interpersonal context, as shown by the synchrony of positive emotions inherent in rapport, was an essential feature in allowing these negative emotions to manifest more often on the faces of someone when they are lying versus when they are telling the truth.

We also found that it was only a subset of specific emotions that betrayed deception. The negative emotions of contempt, disgust, fear, and sadness have been shown to correlate with deception in previous work, but only to the extent to which the liar feels high stakes for their lies

(Ekman, 2009; Frank & Ekman, 1997; Matsumoto & Hwang, 2018; Shen, et al., 2021). Save for contempt, that pattern was replicated here in the high-stake situation in which rapport occurred. In particular, the strongest trend was for the emotions of disgust, fear and sadness, with the latter two emotions each appearing approximately three times more often during a lie than during a truth. As per previous research (Hatz & Bourgeois, 2010), we saw that anger expressions trended in the opposite direction, and were shown more often in the truthtellers compared to liars, although in this study that pattern did not reach statistical significance.

The finding concerning stakes has been raised and debated before (e.g., Ekman, 1985/2009; Frank & Svetieva, 2012), but the moment by moment analysis, aligned with the words spoken, is rarely done. However, studies that do align the two, for example, the content of distressed public pleas for abductions by those innocent or guilty of the abductions, showed that discrepant emotions were the best predictor of dishonest pleas (ten Brinke, et al., 2012). Other studies have looked at frame by frame durations of the specific emotions, and found that the shorter micro expression more diagnostic of deception (Matsumoto & Hwang, 2018). We have also seen how specific questions can produce different diagnostic behavioral displays (Matsumoto & Hwang, 2020). However, neither placed the presence of the facial emotion in the context of the words spoken to identify a discrepant "hot spot" (Ekman, 1985/2009; Frank et al., 2006) or 'anomaly" (Moskal, 2013).

The finding that facial expressions of negative emotions are more predictive of lying when in higher levels of rapport is novel (although observations based on real interrogations proposed it; Frank et al., 2006). Studies have examined how the liking associated with rapport affected the amount of detail produced in the statements (Hwang & Matsumoto, 2020), and that rapport produced more accurate accounts from witnesses (Collins, et al., 2002), and that rapport

produced more personal disclosure (Dianiska, et al, 2021; Novotny, et al., 2021). The fact that these emotions more clearly distinguished people when they were lying from when they were truth telling, but only under high and medium synchrony of happiness, suggests rapport adds two benefits to interviewers. First, the majority of the literature on rapport builds rapport through verbal means (disclosure, identifying similarity, etc); but this study shows again that nonverbal means are just as powerful (as did Chartrand & Bargh, 1999; Novotny, et al., 2021, and Tickle-Degnen & Rosenthal, 1990). Second, it shows that rapport gives an interviewer not only more accurate and detailed verbal information from interviewees, but it provides a ambience that allows the expressive signals of negative emotions to reveal themselves when a lie is told. What is unclear is whether this happens because rapport suppresses the ambient anxiety inherent in any theft type interview, thus suppresses the negative emotion when telling the truth, or whether it is due to the liars now feeling stronger negative emotions because of their violation of the trust element of rapport. Figure 1 suggests the latter explanation. This will be addressed in future research.

There were some limitations in this study. First, the level of synchrony was not randomly assigned, but ascertained through the coding of Duchenne smiles. Synchrony of behaviors are a standard marker of rapport (e.g, Chartrand and Bargh, 1999; Dunbar, et al., 2020), and we were able to obtain synchronized happiness expression in groups of friends and strangers, thus speaking to the robustness and potential utility of this marker in real life interview situations (where more often than not the interlocutors are strangers). However, the behavioral patterns reflective of rapport were not manipulated, thus we cannot conclude rapport caused these negative emotions to emerge.

As second issue is that we had a sample of 48 participants. This is comparable to other studies (e.g., Shen et al., 2021, had a sample of 32 individuals). Moreover, the hit rate analysis showed the results were not driven by outliers, as using a simple decision rule of more negative emotions in the lie versus truth produced hit rates under higher rapport (66%) was considerable higher than under lower rapport (25%).

These results do suggest an additional strategic element in building rapport besides a general mirroring of nonverbal behaviors in the body (Chartrand & Bargh, 1999) or in the body and face (Dunbar, et al., 2020). It alludes to mirroring a specific facial action – a Duchenne or 'enjoyment' smile – as the optimal marker or producer of rapport. If an interviewer can build this level of rapport, by mirroring this expressions, it suggests that the emotional clues become even more diagnostic. We of course caution that no behavioral clue guarantees a lie has been told (Ekman, 1985/2009), but the presence of a negative emotion that is not consistent with the specific topic or description would be a 'hot spot' which would suggest to the interviewer that this topic is an area to further pursue (Frank, et al., 2006). A similar approach showing the detail associated with specific thematic content within the larger individual statements was more diagnostic of deception that just tabulated the total amount of detail, also points to the utility of our approach (Palena, Caso, & Vrij, 2019). Research shows that the only way one knows for sure whether someone is lying is through unimpeachable corroborating evidence (Ekman, 1985/2009; Novotny, et a l., 2018; Park et al., 2002). Thus an investigator would be well advised to build rapport through whatever means until they see reflected positive emotions on the part of the interviewee, then look for negative emotions that don't fit the line, and note the topic discussed when that emotion was triggered, and follow up with more questions to ascertain the nature of

that discrepancy. However, at a minimum, it is a further piece of evidence for the utility of building rapport in any investigative interview.

Taken together, this study showed that when the stakes are raised, and the facial expressions of emotion are coded, examined in the proper intrapersonal context, and the proper interpersonal context is imposed, then negative emotions can betray deception. This variable is also reliably defined, detected, and quantified by independent trained coders in FACS. Therefore, these results directly address the criticism that: "Lie tellers are supposed to leak nonverbal cues to deception, but what these leaking nonverbal cues are remains undefined. The (unspecified) cues could literally be any behaviour." (Vrij, et al., 2022, p. 3). The results of our study, based on Darwin's (1872) theorizing, plus that of others (e.g., Ekman, 1985; 2007; Frank & Ekman, 1997; Frank & Svetieva, 2012; Porter & ten Brinke, 2008), as well as empirical findings from independent laboratories (e.g., Frank & Ekman, 2004; Matsumoto & Hwang, 2018; Shen, et al., 2021; ten Brinke et al., 2012) suggest this declaration is not, or is no longer, true. Nor is it pseudoscience (c.f. Denault, et al. 2020). As has been argued in the past (Frank & Svetieva, 2012), science cannot throw out the nonverbal emotional expressions with the theoretical bathwater when considering deception clues. This is not a plea to stop very promising research in verbal domains (Vrij, et al., 2022), but to allow that under the right stakes, analysis, and interactional style, quantifiable nonverbal signs of emotions can be a productive addition to our knowledge.

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Table I

Means and standard deviations for negative emotion as a function of veracity and synchrony of happiness

	Veracity			
	Truth		Lie	
Synchrony of Happiness	M	SD	M	SD
Low	2.31	1.991	2.19	2.664
Medium	2.19	2.482	5.52	5.006
High	3.27	3.58	6.91	7.204

Table II

Means and standard deviations for each negative emotion as a function of truth/lie

	Truth		Lie	
Negative Emotion	M	SD	M	SD
Disgust	1.58	1.99	2.29	3.19
Fear	0.40	1.05	1.33	1.97
Sadness	0.29	0.65	0.92	1.84
Contempt	0.06	0.25	0.10	0.31
Anger	0.15	0.74	0.08	0.45

Figure 1.

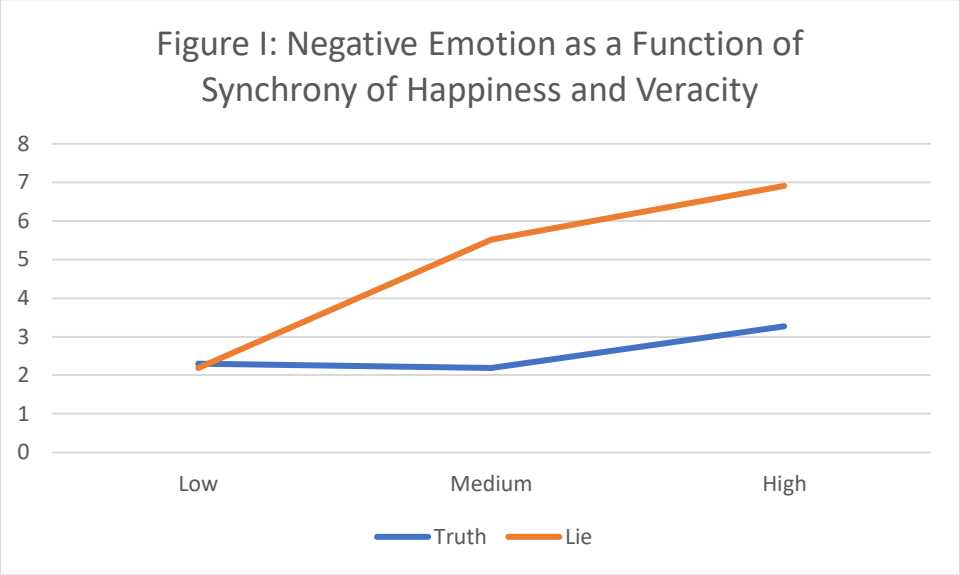
Figure I: Negative Emotion as a Function of Synchrony of Happiness and Veracity
8
7
6
5
4
3
2
1
0
Low
Medium
High
Truth
Lie