Dynamically Engaged Smiling Predicts Cooperation Above and Beyond Average Smiling Levels

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Abstract

Smiling has been conceptualized as a signal of cooperative intent, yet smiles are easy to fake. We suggest that contextually appropriate, dynamically engaged smiling imposes an attentional cost, thereby making engaged smiling a plausible “honest signal” of cooperative intent. To test this hypothesis, we analyzed data from 123 pairs of same-sex strangers having “getting-to-know-you” conversations who subsequently played a one-shot prisoner’s dilemma together. We calculated the strength of engagement in smiling using a cross-lagged auto-regressive model for dyadic data. We found that when an individual’s partner (the signaler) tended to smile in a more responsive way, that individual (the receiver) was more likely to cooperate. Conversely, when a signaler tended to smile in a less responsive way, the receiver was less likely to cooperate. These effects were present over-and-above the effects of average levels of smiling and self-reported liking, which also predicted likelihood of cooperation. However, dynamically engaged smiling did not predict cooperation on the part of the signaler, suggesting that receivers weight the importance of engagement more highly than they should, or even that engaged smiling might be a manipulative display. These results illustrate how conversational dynamics can influence evolutionary signaling.

WORD COUNT: 192

Introduction

What does a smile communicate? Smiles are a common social display, but they are interpreted differently based on the way they are displayed (Ambadar, Cohn, & Reed, 2009; Ekman, Davidson, & Friesen, 1990; Krumhuber & Manstead, 2009; Schmidt, Ambadar, Cohn, & Reed, 2006). For example, Duchenne smiles—those that include the activation of the orbicularis oculi muscle in addition to upturned corners of the lips—convey a more intense feeling of enjoyment to a viewer (Ekman, Davidson, & Friesen, 1990; Gunnery, Hall, & Rubin, 2013; Krumhuber & Manstead, 2009; Williams, Senior, David, Loughland, & Gordon, 2001). Smiles can also be classified as polite, amused, embarrassed, or nervous based on both static and dynamic cues, such as the onset speed and duration of a smile, how far forward the head is tilted, and how much the mouth is open (Ambadar, Cohn, & Reed, 2009).

Understanding what a smile means is important because smiles influence the inferences people draw about others, and decisions about who to trust and cooperate with (Albright et al., 1997; Johnston, Miles, & McCrae, 2010; Schmidt, Levenstein, & Ambadar, 2012; Centorrino, Djemai, Hopfensitz, Milinski, Seabright, 2015; Reed, Zeglen, & Schimdt, 2012). Smiling individuals tend to be rated as more trustworthy, and individuals smiling more intensely are judged more positively (Johnston, Miles, & McCrae, 2010; Schmidt, Levenstein, & Ambadar, 2012). People are more cooperative with and prefer to play cooperative games with individuals represented by a smiling icon or photograph, or with an icon that is smiling more (rather than less) intensely (Brown & Moore, 2002; Eckel & Wilson, 2000; Scharlemann, Eckel, Kacelnik, & Wilson, 2001).

Smiling is also related to the sender's affiliative intent. Those who display more genuine smiles tend to return more money to partners in the investor game (Centorrino, Djemai, Hopfensitz, Milinski, Seabright, 2015). Individuals categorized as stable cooperators in an ultimatum game tend to smile more, in addition to being generally more expressive (Schug, Matsumoto, Horita, Yamagishi, Bonnet, 2010). Additionally, individuals who smiled while making an explicit verbal commitment to cooperate on a prisoner's dilemma game were more likely to honor that commitment (Reed, Zeglen, & Schimdt, 2012). The literature thus suggests that the decision to trust smiling people is ecologically rational. Smiling appears to accurately reflect an individual's intent to cooperate.

Given that smiling is both a reliable indicator of cooperative intent and is used by individuals to judge others' cooperative intent, smiling can be considered in an evolutionary signaling framework (Cronk, 2005; Gintis, Smith, & Bowles, 2001; McCullough & Reed, 2016; Smith & Harper, 1995). In this framework, displays are divided according to their evolved function. *Cues* are reliable sources of information that perceivers can use to guide action. For example, when a wolf bares its teeth, the size of the tooth is a reliable source of information about the severity of its bite (McCullough & Reed, 2016). Smiles can be treated as cues when they reliably index internal states. For example, a spontaneous smile in response to a joke could be a cue, because it is a reliable indicator that an individual is feeling amusement. If a perceiver believes that individuals feeling amusement are more likely to be cooperative, this could guide the perceiver's cooperative decisions.

Signals are displays (or structures, such as the peacock's tail) that increase the signaler's fitness by eliciting a desirable reaction from another organism, but would otherwise reduce the signaler's fitness (Smith & Harper, 1995). Additionally, researchers have specified that signals

should also increase the fitness of the receiver—otherwise they are considered “coercive displays” (McCullough & Reed, 2016; Scott-Phillips, 2008). As an example, FitzGibbon and Fanshawe (1988) suggested that when the Thompson’s gazelle springs straight into the air (a behavior called “stotting”), it signals to predators that it is fit and capable of evading them. This jumping behavior is empirically associated with the gazelle’s ability to outrun predators, and so it *honestly* signals to the predator that it would not be worthwhile to chase that particular animal. Predators, in turn, choose to chase gazelles that jump less often, conserving their energy and increasing their likelihood of success. The stotting signal conveys a benefit to the gazelle, because it does not have to expend energy being chased or incur the risk of being eaten. It conveys a benefit to the predator as well, because the predator also will not have to expend energy in a chase with low likelihood of success. If stotting did not reliably indicate the gazelle’s ability to outrun predators, but instead “tricked” predators into avoiding them, it would be considered a coercive display.

In human interaction, we might describe such displays as “manipulative” in the sense that they lead interaction partners to believe something that is not true, to the signaler’s own advantage. This is not to say that manipulative displays in humans need be the result of conscious calculation or manipulative intent. Instead they could be displays that elicit benefits from others (such as trusting and listening carefully to a speaker who makes eye contact) even if they do not reliably index the relevant characteristics of the person displaying them (such as the speaker’s actual knowledge or trustworthiness). If listeners use eye contact to assess information quality, but eye contact is not reliably related to information quality, then eye contact has the statistical properties of a manipulative display, even if deception is not consciously intended by the speaker.

Smiles can be considered signals if they are meant to elicit a reaction from another organism that increases the fitness of the person smiling and the person being smiled at, and if they reduce fitness in other contexts. For example, an individual might display a friendly smile to elicit cooperative behavior from an interaction partner, but this friendly smile could convey weakness in confrontations—leading to a higher likelihood of being attacked. Additionally, the friendly smile would be a signal—and not a manipulative display—if it accurately indexed the intention of the smiler to act cooperatively him- or herself. On the other hand, if a smile were to elicit cooperation from another person, but was *not* predictive of the smiler's own intention to cooperate, this would be a manipulative display. This smile would lead the receiver to provide benefits, without the signaler having to reciprocate.

It is important to note that when we describe smiling “to elicit cooperation,” we do not necessarily mean that an individual is consciously aware of a motive to elicit cooperation, any more than we think a peacock consciously chooses to grow a large tail to attract mates, or that a gazelle is consciously calculating when to leap in the air. Rather, the process of evolution has selected for this behavior because it elicits fitness-enhancing effects from other organisms. The gazelle might simply feel an impulse to jump when a predator is nearby, without engaging in any conscious calculation of whether jumping is helpful or not. Analogously, smiling might be a signal of cooperative intent, even though there is no conscious deliberation about when to smile to best influence another person. Instead there might just be moments when it “feels right” to smile, but that have nonetheless been selected for through evolutionary dynamics.

Further, evolutionary dynamics can occur at multiple levels of analysis, including the genetic, epigenetic, behavioral, and cultural levels (Jablonka & Lamb, 2005; Henrich & McElreath, 2003; Boyd & Richerson, 1985; Laland et al., 2015). Smiling might therefore

develop as a signal of cooperative intent across repeated interactions with others, where individuals learn to smile and interpret smiles whenever cooperative intent is present, or it might be a signal that is learned through exposure to exemplars and reinforced through cultural messages. For example, an upper middle class American might learn both to smile when he is feeling cooperative and to interpret smiling people as cooperative through social learning, without these behaviors being “hardwired” genetically in the way that a startle reflex is.

Signals, according to the definition put forward by Scott-Phillips (2008), should increase the fitness of both the signaler and the receiver—yet once a signal is established, organisms may attempt to exploit it. For example, an individual might smile but not have cooperative intentions. The individual is thus trying to lure the receiver into being more cooperative, but ultimately is not going to provide the expected benefit. The problem with smiles, as with many signals, is why receivers continue to use them to guide action, in the face of potential exploitation. What maintains their honesty?

Models of the evolution of signaling demonstrate that imposing a cost on the sender can maintain a signal’s honesty (McCullough & Reed, 2016; Scott-Phillips, 2008; Smith & Harper, 1995). Smiling is not typically thought to be a costly signal, because smiles do not impose any significant cost on the smiler. Recently, however, Pentland and Heibeck (2010) proposed that social engagement can be an honest signal, because engagement requires investment of active attention on the part of the sender. When considered in the unfolding dynamic of a conversation, therefore, smiling may become a costly signal. Smiling at the appropriate moment, in response to the smiles and other social cues on the part of a partner, costs the smiler attention. In an information-rich ecology, where many other stimuli contend for an individual’s attention, engagement may send a signal that the engaged smiler values the receiver.

Recent research finds that people often want to avoid empathy, even when the experiences being shared are positive (Cameron et al., 2016). Reviews of prior work have suggested that people are motivated to avoid empathy for others feeling negative emotions, because they do not want to experience these negative emotions themselves (Zaki, 2014; Cameron & Rapier, 2017). This addresses the emotional cost of engaging in empathy, but there is also a cognitive cost to empathy. Perspective taking and empathic accuracy are effortful processes (Epley et al., 2004; Sabbagh & Taylor, 2000; Ma-Kellems & Lerner, 2016). Based on a rich body of research finding that people are “cognitive misers”—meaning they prefer to avoid effort—researchers have found that, when given a choice, participants avoid empathy for both positive and negative experiences (Cameron et al., 2016). This is related to perceptions by these participants that empathy is effortful and uncomfortable. Engaged smiling therefore may be a way of demonstrating commitment to another individual by spending limited attention and cognitive effort to share an experience with that person.

Social engagement has also been linked to prosocial outcomes in studies of mimicry and synchrony (Chartrand & Lakin, 2013; Hatfield, Caccioppo, & Rapson, 1993; Feldman, 2007). For example, synchrony has been found to increase helping (Valdesolo & DeSteno, 2011). Mimicry has been found to increase liking of a social partner, to be exhibited more by empathic individuals, to be more likely when an individual has an affiliative intent, and to lead to better outcomes for both parties in business negotiations (Chartrand & Lakin, 2013; Maddux, Mullen, & Galinsky, 2008). Studies also suggest that mimicked individuals show more prosocial behavior (van Baaren, Holland, Kawakami, & Van Knippenberg, 2004).

People tend to mimic smiles. For example, seeing a target’s smile tends to prime the viewer’s smiling (Korb, Grandjean, & Scherer, 2010). In a study using facial electromyography

(EMG), when one individual told an emotional story to another, the activity of muscles related to smiling were found to correlate between partners (Hess & Bourgeois, 2010). Alcohol also increases mutual smiling, particularly the likelihood of a smile becoming mutual in all-male groups (Sayette et al., 2012). Correlations between interaction partners' Duchenne smile intensities tend to increase while they are making commitments to cooperate (Reed, Zeglen, & Schmidt, 2012). Although some work suggests that simulating another's smile can facilitate accurate interpretation of that smile (Maringer, Krumhuber, Fischer, & Niedenthal, 2011; Niedenthal, Mermillod, Maringer, & Hess, 2010), prior research does not establish how *dynamically engaged* smiling will influence prosocial outcomes. Research has therefore established that individuals smile in an engaged way, that engagement generally can lead to prosocial behavior, and that engagement may be a costly signal. In this study, we apply these insights to the question of why smiles appear to be treated as signals of cooperative intent.

Shared Positive Emotions and Smiling

The current study uses a data set collected and coded over the course of two years, in which pairs of same-sex participants with no prior acquaintance viewed an emotion-eliciting film clip together, engaged in a five-minute "getting to know you" conversation, and subsequently completed a prisoner's dilemma task as well as self-report measures of affiliation. The purpose of this study was to examine the influence of different positive emotions on specific social behaviors that were hypothesized, in turn, to influence affiliation and cooperation. Three positive emotions were examined - amusement, awe, and pride – and specific mechanisms through which they might increase cooperation relative to a neutral-affect control condition were

predicted in advance. Our initial hypothesis was that amusement and awe would each increase the likelihood of cooperation, but that each might do so via a different mechanism.

Before the “getting to know you” conversation, participant dyads watched short film clips together, each eliciting one of the four target emotional states: amusement, awe, pride, or a neutral control. Based on previous findings that strong smiles are included in the prototypical facial expression of amusement, but *not* pride or awe (Campos et al., 2013; Tracy & Robins, 2007), we hypothesized that amusement alone might promote cooperation by increasing smiling during the getting-to-know-you conversation. Initial, *a priori* hypotheses emphasized average smiling over the course of the conversation. The model was expanded to include dynamically engaged smiling as a predictor due to the first author’s growing expertise in dynamic systems modeling, and in the data analysis techniques needed to operationalize this aspect of smiling behavior. Indeed, mimicry was another mechanism by which we had expected amusement might enhance cooperation. Amusement has been found to increase mimicry, whereas pride has been found to decrease it (e.g., Dickens & DeSteno, 2014; van Baaren, Fockenberg, Holland, Janssen, & van Knippenberg, 2006); we therefore hypothesized that amusement might increase dynamically engaged smiling which would, in turn, increase cooperation.

Study measures also included other mechanisms through which awe might increase cooperation: asking questions of the interaction partner, and viewing the partner as more complex. The hypotheses regarding awe were not supported by data analyses, reported in the first author’s unpublished Master’s Thesis (Danvers, 2015). We did not expect that pride would promote cooperation by any mechanism assessed in the study. The current study is the first we

have conducted addressing the effects of dynamically engaged smiling on cooperation, and this is the first scientific publication to emerge from this data set.¹

The Current Study

In this study, we examined smiling across the course of a five-minute “getting to know you” conversation among pairs of same-sex strangers. After the conversation, individuals played a one-shot prisoner’s dilemma game with each other (Axelrod, 1980; Reed, Zeglen, & Schmidt, 2012; Rapoport & Chammah, 1965). We were interested in the way that smiling across the conversation—in particular, measures of dynamically engaged smiling—would be related to cooperation on the prisoner’s dilemma game. Based on prior literature, we expected that the average amount of smiling displayed by the signaler across the conversation would be related to the likelihood of that signaler cooperating (Reed, Zeglen, & Schmidt, 2012; Schug et al., 2010). We also anticipated that greater average smiling by a signaler would predict higher likelihood of the receiver’s (the person being smiled *at*) cooperation (Scharlemann, Eckel, Kacelnik, & Wilson, 2001). However, we further expected that measures of dynamically engaged smiling throughout the conversation would predict likelihood of cooperation, above and beyond the

¹ We also conducted a concurrent pilot study in which positive emotions were manipulated separately (e.g. participants watched the manipulation videos on separate computer monitors as opposed to a large common TV monitor). We also coded the videos from this study. To ensure that our results were robust, we completed the same analyses reported below both in our main study (reported in this manuscript) and in the combined sample of the main study and the pilot study. Including this secondary study of emotion and social interaction led to the same substantive pattern of effects, and did not change the significance of any of our coefficients. These results are presented in supplementary materials. Additionally, power was calculated for the original study based on a single factor ANOVA with four groups. For an expect effect of $f = .30$, 128 participants are required to reach 80% power. Power was not calculated for the secondary analysis, since the project was completed. By including the pilot study in the supplementary materials, we are reporting on all studies we conducted on this topic.

effects of average smiling levels, for both the signaler and the receiver. Finding this would support the theoretical argument that dynamically engaged social displays can be considered honest signals (Pentland & Heibeck, 2010).

We used the Actor Partner Interdependence Model (APIM) to estimate the effects of each smiling signal (average and dynamically engaged smiling during the conversation) on both the signaler's and the receiver's behavior in the prisoner's dilemma (Kenny, Kashy, & Cook, 2006; Olsen & Kenny, 2006). In the APIM each participant in the study serves both as a signaler and as a receiver in statistical analyses, thereby maximizing statistical power. The APIM approach, originally developed for research on dyads without explicit reference to the evolutionary signaling literature, also allows for a clear test of whether a given display is either a signal or a manipulative display. In the model, the degree to which each participant displays a signal is used to predict both the likelihood of his/her own cooperation and the likelihood of the interaction partner's cooperation.

If a display is a cue or signal, then presence of that behavior will predict both the behavior of the signaler and the behavior of the receiver. In the context of the prisoner's dilemma, this would mean that greater smiling predicts greater likelihood of cooperation by both the signaler and the receiver. This would be an instance of honest signaling, where both individuals get a benefit from the signal. If the display is manipulative, then greater smiling will predict cooperation by the receiver, but *not* by the signaler. This asymmetry would suggest that receivers base their decisions on the display of smiling, but smiling does not accurately reflect the signaler's likelihood of cooperating.

Smiling might be considered an indicator of liking—which would then increase cooperation—rather than an independent signal of cooperative intent. Indeed, closeness among

friends has been linked to the amount of money individuals are willing to give up for another person, and to decisions to cooperate in a prisoner's dilemma (Jones & Rachlin, 2006; Locey, Safin, & Rachlin, 2013). To test whether dynamically engaged smiling was an independent signal of cooperative intent, we include a measure of self-reported liking as a covariate in our model. If dynamically engaged smiling is a signal independent of cooperative intent, then the effect of engaged smiling should be a significant predictor of cooperation above-and-beyond the liking covariate. This would suggest that even if an individual doesn't particularly like their partner, they would still be more likely to cooperate with that person if the partner displayed engaged smiling.

Methods

Participants

135 same-gender dyads—270 individuals—participated in the study. Participants were undergraduates enrolled in an introductory psychology course at Arizona State University, at least 18 years of age, who received course credit in addition to a \$5 payment. They were able to win up to \$5 more based on the outcome of the prisoner's dilemma.

One dyad was removed because individuals of different genders signed up for the session (despite instructions specifying that participants should be of the same gender). Eleven dyads were removed because either the emotion videos did not play properly, or the video of the participants interacting did not record properly. The final sample included 123 dyads. Of these, 48% were female/female dyads. Average age was 19.4 years old. In terms of ethnicity, 53.7% of participants were European American/White, 17.1% were East or Southeast Asian, 16.3% were Hispanic/Latino, and 3.3% were South Asian and African American/Black.

Procedure

Participants were randomly assigned to one of three positive emotion inductions or a neutral control induction. Inductions were ~2 minute videos intended to elicit amusement (the “Kyle’s Mom” scene from the *South Park* movie), awe (video moving in perspective from the outer edges of the known universe to the sub-atomic level), pride (clip from a video highlighting academic excellence at the participants’ university), or neutral affect (instructions on how to build a wall) watched together on a large, wall-mounted monitor. All participants also completed a positive emotion “booster,” writing about a personal experience evoking the target emotion state for three minutes.

Participants then completed a five-minute, unstructured “getting to know you” conversation, during which they were told they could talk about any topic. These conversations were video recorded with participants’ knowledge and consent for behavioral coding. After the conversation, a visual divider was placed between participants, and they completed questionnaires assessing liking of the partner, demographics, and personality measures not considered here.²

The divider was then adjusted so that participants could see the experimenter, who explained to participants the next task they would complete: a one-shot prisoner’s dilemma. The

² Participants completed measures of the Big Five personality traits for themselves and partners, and measures of their dispositional tendency to experience positive emotions. Because these did not assess affiliation specifically toward the interaction partner, they are not included in the present analyses. Analyses of these data are being prepared for presentation in another manuscript.

divider still prevented participants from seeing each other's faces.³ In the prisoner's dilemma game, participants choose independently whether to cooperate or defect, and each person's outcome is a function of their joint decisions (for additional task detail see Reed, Zeglen, & Schmidt, 2012). Participants privately indicated on a form whether they wanted to "cooperate" or "compete" (the term "compete" replaced "defect" for clarity, and to avoid antisocial connotation). They then completed another complex behavior task that did not directly assess cooperative intent⁴. At the end of the session, participants received a cash payment based on their responses: \$3 each if both cooperated; \$1 each if both competed; and in case of differing choices, the cooperator received \$0 and the competitor \$5.

Measures

Coding of Smiling Behavior. Individual participants' smiling during the five-minute conversation was coded in 10-second intervals or "bins." In each bin, smiling was given a score from 0 (not present) to 3 (high intensity) based on both duration within the bin and movement intensity (considering extent of lip corner movement as well as presence of cheek movement and "crow's feet" wrinkles indicating contraction of the orbicularis oculi muscles), consistent with Ekman and Friesen's Facial Action Coding System (FACS; 1978). Coding was performed by two teams of trained research assistants over two years: three coders in year one, five in year two. Approximately one third of the videos coded by each research assistant overlapped with

³ Full experimental sessions were video recorded for most pairs of participants; researchers wishing to do secondary data analysis or closely replicate the procedure used are encouraged to contact the authors to request further materials related to the experimental protocol.

⁴ This task, called the fishing game, involved back and forth decision-making dynamics, such that the ultimate outcome of the game was due to a mixture of impulse control, social norms, and cooperative intent. A further manuscript is being prepared that more fully explores the various metrics that can be derived from these decision-making dynamics.

one or more other research assistants, in order to assess reliability. Average pairwise reliability across coders, based on the intraclass correlation coefficient (ICC), was .675 using random effects. Coding used in subsequent analyses was randomly selected from among the research assistants who had coded a given participant.

Self-Report Measure of Liking. Liking was measured through five questionnaire items rated on a five-point Likert scale (Cronbach's $\alpha = 0.84$), such as “how much did you like interacting with your partner?” and “how much do you like your partner as a person?” These items were averaged to form an overall liking score.

<Insert Table 1 About Here>

Results

We conducted our analyses in two steps. In the first step, we estimated cross-lagged regression models predicting smiling over time for each dyad. Smiling for each actor at a given time point was predicted from his or her own smiling at the previous time point, as well as the partner's smiling at the previous time point. Four parameters were estimated from this model: the effect of actor A's smiling at time t on their own smiling at time $t+1$ (autoregressive effect for A, or “independent smiling”) and on their partner's smiling at time $t+1$ (cross-lagged effect on B, or “engaged smiling”); and the effect of actor B's smiling at time t on their own smiling at time $t+1$ (autoregressive effect for B; independent smiling) and on their partner's smiling at time $t+1$ (cross-lagged effect on A; engaged smiling). These four parameter estimates were saved for use in further analyses. The model being estimated is displayed in Figure 1.

<Insert Figure 1 About Here>

In the second step, we examined how average, independent, and dynamically engaged smiling influenced cooperation. In this model the term “actor” refers to the participant whose cooperation is being predicted, and the term “partner” to that individual’s partner. Significant actor effects indicate effects driven by the participant as signaler/smiler, and partner effects indicate effects driven by the participant as receiver/observer of smiling. In our data set, defection was coded as 1 and cooperation was coded as 0, so a positive coefficient indicates a higher likelihood of defection and a negative coefficient indicates a higher likelihood of cooperation. Predictors of cooperation/defection included: the average amount of smiling by both actor and partner; independent smiling by both actor and partner; and dynamically engaged, responsive smiling by both actor and partner (independent and dynamically engaged smiling were estimated in step 1, above).

In addition to these smile variables, we also included the following covariates: three dummy codes representing the effects of the emotion conditions, one dummy code representing the effect of gender, and the effect of self-reported liking by the actor and the partner. The dummy codes were all at the between-dyad level, meaning that both members of the dyad experienced the same emotion manipulation, and dyads always consisted of same sex individuals. These dyad-level variables were used to predict all the smiling terms, self-reported liking, and the ultimate decision to cooperate. Liking was only used to predict cooperation, and

not emotion condition or gender. The estimated model, including only significant effects, is presented in Figure 2⁵.

There was only one significant effect of the dyad-level variables on smiling. Women tended to smile, on average, more than men ($b = -0.594$, $Z = -5.113$, $p < .001$). Gender did not influence the signaler's independent smiling ($b = -0.002$, $Z = -0.043$, $p = .966$), nor the receiver's dynamically engaged smiling ($b = -0.023$, $Z = -0.535$, $p = .592$). Contrary to prediction, none of the dummy codes representing the contrast between positive emotion conditions and neutral control were significant in predicting any aspect of smiling (for average smiling, awe: $b = 0.079$, $Z = 0.513$, $p = .608$; amusement: $b = 0.174$, $Z = 1.193$, $p = .233$; pride: $b = 0.166$, $Z = 1.111$, $p = .267$; for independent smiling, awe: $b = -0.015$, $Z = -0.236$, $p = .813$; amusement: $b = -0.028$, $Z = -0.462$, $p = .644$; pride: $b = -0.009$, $Z = -0.131$, $p = .896$; for dynamically engaged smiling, awe: $b = 0.045$, $Z = 0.609$, $p = .543$; amusement: $b = 0.052$, $Z = 0.771$, $p = .449$; pride: $b = 0.055$, $Z = 0.745$, $p = .456$).

Likelihood of cooperating was also predicted by gender; men were more likely to cooperate than women overall ($b = -0.660$, $Z = -2.628$, $p = .009$). None of the dummy codes for emotion condition were significant predictors of cooperation (awe: $b = 0.177$, $Z = 0.602$, $p = .547$; amusement: $b = 0.261$, $Z = 0.856$, $p = .392$; pride: $b = 0.184$, $Z = 0.588$, $p = .557$). The actor's liking of the partner ($b = -0.279$, $Z = -2.119$, $p = .034$) and the partner's liking of the actor ($b = -0.229$, $Z = -1.973$, $p = .048$) were both significant predictors of cooperation.

Cooperation was also predicted by average, independent, and dynamically engaged measures of smiling. The more an actor smiled, on average, the more likely she or he was to

⁵ Full output of the structural equation model is available in supplementary materials. Estimates of each effect are reported in the text.

cooperate (actor/signaler effect, $b = -0.463$, $Z = -4.100$, $p < .001$). The more an actor was *smiled at*, on average, the more likely she or he was likely to cooperate as well (partner/receiver effect, $b = -0.334$, $Z = -2.853$, $p = .004$). In addition, the more an actor's smiling *influenced* their partner's smiling (i.e., higher partner dynamically engaged smiling), the more likely the actor was to cooperate ($b = -1.082$, $Z = -3.361$, $p = .001$). The more the partner's smiling was uninfluenced by the actor (i.e., higher partner independent smiling), the less likely the actor was to cooperate ($b = 0.989$, $Z = 3.448$, $p = .001$). These both reflect receiver effects, in which the actor's cooperation decision is influenced by the extent to which the partner's smiling is dynamically responsive to the actor, rather than independent. Contrary to hypotheses, no signaler effects were observed: neither the degree to which the actor's smiling was dynamically engaged with their partner ($b = -0.414$, $Z = -1.221$, $p = .222$) nor the degree to which the actor's smiling was independent of the partner ($b = 0.516$, $Z = 1.520$, $p = .129$) significantly predicted the actor's own decision to cooperate. The model overall predicted approximately 36% of the variation in cooperation.

<Insert Figure 2 About Here>

Discussion

We asked pairs of same-sex strangers to watch short videos eliciting amusement or an alternate emotion state, to have five-minute “getting to know you” conversations, and then to choose whether or not to cooperate with each other on a prisoner's dilemma game. We coded the amount of smiling for each participant every 10 seconds throughout the conversation. We

found that not only average smiling by both actor and partner, but also the extent to which the actor's smiling dynamically influenced the conversation partner's smiling, significantly and independently predicted an actor's likelihood of cooperating. These effects were statistically significant even after controlling for self-reported liking by both participants, suggesting that smiling predicts affiliative intent independent of how much participants actually liked each other.

Average measures of smiling by both an actor and her or his partner influenced the actor's cooperation, providing evidence for both signaler and receiver effects in this aspect of smiling. These measures capture how much dyad members smiled overall, but not how dynamically engaged with each other they were when smiling. In line with prior evidence, this actor effect suggests that individuals signal their likelihood to cooperate by smiling (Reed, Zeglen, & Schmidt, 2012; Schug et al., 2010). Decisions about cooperation are also predicted by the conversation partner's average smiling. Assuming that an individual would only decide to cooperate when they thought their partner was also likely to cooperate—in other words, that individuals are motivated to avoid the “sucker's payoff” in the prisoner's dilemma game—then this partner effect suggests that smile receivers interpret the average amount of smiling by a partner as a signal that the partner is likely to cooperate. This result supports the hypothesis that overall levels of smiling are a reliable signal of cooperative intent.

Consistent with our predictions, actor decisions to cooperate were also predicted by measures of the partner's dynamically engaged smiling. These measures include the degree to which the partner's smiling was independent of the actor's smiling, as well as the degree to which the partner's smiling was influenced by the actor's smiling. Both of these reflect receiver effects, suggesting that individuals are sensitive to the dynamically engaged smiling of their interaction partners when deciding whether to cooperate. An actor is more likely to cooperate

with a partner who is more dynamically engaged in her or his smiling, and less likely to cooperate with a partner whose smiling is more independent. These are separate effects, which hold above and beyond the effects of average amount of smiling, and of liking. These effects imply that people consider how engaged their partner's smiling is when determining whether to cooperate.

Contrary to our predictions, however, an actor's own dynamically engaged smiling was *not* a statistically significant predictor of her or his own decision to cooperate. Neither the dynamic engagement nor the independence of an actor's smiling significantly predicted that actor's decision to cooperate. In other words, engaged smiling did not meet the statistical requirements for being considered a signal. If a display is a signal, then it should accurately predict one's subsequent behavior, thereby benefitting both the signaler and the receiver. If the display only benefits the signaler, but not the receiver, then it is typically categorized as coercive or manipulative. Because dynamically engaged smiling predicted the receiver's behavior but not the signaler's behavior, engaged smiling in conversations might be a manipulative display, intended to elicit cooperation without necessarily accurately representing the signaler's intentions.

The idea that dynamically engaged smiling may be a form of social manipulation is only a tentative hypothesis, however. First, although the effects for actor engaged smiling were not statistically significant, their direction was consistent with the hypothesis that they are honest, non-manipulative signals. That is, the directions of parameter estimates indicated that actors whose smiling was more dynamically engaged and less independent of partner smiles were more likely to cooperate, although these effects did not reach significance. Given the standard errors of these effects, however, we cannot reject the possibility that the effect is actually zero in the

population. Before concluding definitively whether dynamically engaged smiling accurately reflects cooperative intent, this result should be replicated with a larger sample.

It is also important to note that the prisoner's dilemma task was separate from the smiling, because participants did not learn about the type of game they would be playing with their partner until after the conversation. This means that participants could not have been smiling with deliberate intent to influence the outcome of the game, as in some paradigms (e.g., Reed, Zeglen, & Schmidt, 2012). Rather, smiling would have influenced psychological mechanisms, like a sense of trust, that later influenced cooperative behavior. Thus, smiling should not be considered a conscious, strategic choice on the part of the participants to elicit cooperation. Rather, it is part of a repertoire of social behaviors that lead to stronger or weaker bonding. Engaged smiling is therefore a manipulative display in the sense that it leads to more trust in the general good intentions of the person smiling than is warranted, because engaged smilers are not necessarily more trustworthy when they are forced to decide whether to cooperate or not.

In our analyses, an actors' average smiling better predicted their own behavior than dynamically engaged smiling. The standardized regression coefficient representing the effect of an actor's own average smiling on her or his decision to cooperate was $\beta = -0.334$, whereas the standardized coefficients representing the actor's dynamically engaged ($\beta = -0.106$) and independent smiling ($\beta = 0.133$) were less than half as large. This suggests that, among the possible signaler effects, average smiling is a better predictor of the signaler's ultimate cooperation than dynamically engaged smiling. The opposite pattern was observed for receiver effects – the extent to which the partner's smiling influences the actor's decision to cooperate. The effect of partner average smiling on an actor/receiver's decision to cooperate was $\beta = -$

0.222, smaller in magnitude than the effects of the partner's dynamically engaged ($\beta = -0.274$) and independent smiling ($\beta = 0.240$) on the actor's decision. This suggests that dynamically engaged smiling is a better predictor of a receiver's response than average smiling. This pattern of coefficients suggests that receivers may weight dynamically engaged smiling too heavily when deciding whether to cooperate.

The results we present here are part of a larger study of emotions and social interaction. Individuals were randomly assigned to experience either awe, amusement, pride, or a neutral control emotion together before engaging in the social interaction. We hypothesized that amusement would lead to greater average smiling than neutral affect, but we did not find this effect. We also hypothesized that amusement would lead to greater dynamic engagement in smiling; we did not find support for this effect, either. If amusement does have such an effect, it is likely much smaller than we had the power to detect with our sample. It may be that smiling is influenced more by emotions experienced during the social interaction than the emotions felt by the individuals heading into the interaction.

Much prior research has found that women tend to smile more often than men (Halberstadt, Hayes, & Pike, 1988; Hall & Halberstadt, 1986; LaFrance & Hecht, 2000). We replicated this effect for our average smiling measures, such that female dyads tended to smile more on average than men. However, we did not find any effect of gender on our measures of dynamically engaged smiling; women were not significantly more or less *responsive* to partners in their smiling than men, at least in the context of a same sex "getting to know you" conversation. We also found a small but statistically significant effect of gender on cooperation. Overall, men were more likely to cooperate than women, after controlling for all other effects. This suggests that men might be more open to forming new coalitions or partnerships than

women, or that women are warier of cooperation with strangers. Further research is needed to establish the robustness and governing conditions of this effect.

Limitations and Future Directions

Like much work on smiling and cooperation, this work was conducted on an undergraduate sample. To generalize more broadly, further research should be conducted on a more diverse and representative population. Additionally, smiling was hand-coded in 10 second windows. However, this is just one particular sampling rate we could have used to study smiling, and coding at a more fine-grained level might have given us a deeper understanding of the underlying dynamics. Further research using second by second coding might give better insight into the nature of matching and turn-taking in conversational smiling.

Conclusion

We began this investigation considering whether smiling – both average smiling across a five-minute interaction, and the extent to which smiling is dynamically engaged with one’s interaction partner – might be considered an honest signal of cooperative intent. To be an honest signal, smiling would need to communicate to a receiver that the person smiling was likely to be cooperative. This does not mean that the smiling signaler was necessarily aware of why she or he was smiling, but it does mean that receivers are influenced by the signal when deciding whether to cooperate or not. Our data support the proposal that average smiling level is used as a signal, as the level of smiling by an actor’s interaction partner increased that actor’s likelihood of cooperation. Moreover, our data also support the proposal that average smiling is an *honest*

signal, as an actor's overall level of smiling accurately predicted that actor's own likelihood of cooperation.

We also examined a potential explanation for what maintains the honesty of smiling as a signal of cooperation: the attentional cost of active, dynamic engagement in the interaction. If dynamically engaged smiling is used as a signal, then when an interaction partner smiles in a responsive, dynamically engaged way the actor should be more likely to cooperate. We found this in our data. For the signal to be *honest*, however, the actor/signaler who smiles in a responsive, dynamically engaged way should actually be more likely to cooperate. We did not find evidence of this in our data. This could be either because a signaler's dynamically engaged smiling does not actually predict their cooperative intent in the larger population, or because the effect is small and we would need a larger sample for it to be statistically significant. Given this finding, it remains possible that engaged smiling is instead a manipulative display that elicits cooperation from others—even though it does not indicate cooperation will necessarily be returned.

This study adds to a growing body of research considering facial expressions from an evolutionary signaling perspective (Dezecache, Mercier, & Scott-Phillips, 2013; Fridlund, 1994; McCullough & Reed, 2016; Reed, Zeglen, & Schmidt, 2012; Reed & DeScioli, 2017). We are the first (to our knowledge) to assess the effects of dynamically engaged smiling in a naturalistic conversation on cooperation. Further research is needed to test the hypothesis that dynamically engaged smiling, and other forms of engaged attention, can be used as a manipulative tactic. Additionally, while our research confirms other findings on smiling and cooperation (e.g. Reed, Zeglen, & Schmidt, 2012), the measures of dynamic engagement we captured here did not fully explain why smiling is treated like an honest signal of cooperative intent. It may be that other

features of smiles and dynamical engagement in smiling will further help explain why smiling is used as a reliable indicator of cooperative intent.

Author Contributions

A.F.D and M.N.S. developed the study concept and design. Data collection and behavioral coding were conducted by A.F.D. and undergraduate research assistants under his supervision. Data analysis was performed by A.F.D., and interpreted by A.F.D. and M.N.S. A.F.D and M.N.S. jointly wrote and edited the manuscript. Both authors have approved the final version of this manuscript for submission.

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Table 1: Descriptive Statistics for Variables in Model

Variable	N	<i>M</i>	<i>SD</i>
Liking, Person A	123	3.778	0.64
Liking, Person B	123	3.63	0.646
Mean Smiling, Person A	123	1.461	0.734
Mean Smiling, Person B	123	1.445	0.716
Auto-correlation Effect, Person A	121	0.156	0.267
Auto-correlation Effect, Person B	121	0.088	0.258
Cross-lag Effect, Person A	121	0.053	0.264
Cross-lag Effect, Person B	121	0.163	0.251
Percent Defecting, Person A	123	18.7%	
Percent Defecting, Person B	123	22.0%	

Note: Because defection is a binary variable, no *SD* is given. Two models for smiling dynamics could not be estimated, because there was no variability in one or the other individual's levels of smiling. The measures of smile dynamics are thus only available for 121 of the 123 dyads.

Figure 1: Dynamic Model of Smile Engagement

Note: An individual's smiling at a given time point is influenced by both the amount of smiling of that individual in the previous time point (an actor effect, labeled a) and the amount of smiling of that individual's interaction partner (a partner effect, labeled p). Both actor and partner effects are estimated simultaneously and independently in step one of modeling. When estimating these models, the amount of smiling for an individual at time t is allowed to correlate, and the disturbance terms of smiling at time $t + 1$ (here labeled Z) are allowed to correlate. In step two, when they are used to predict cooperation, actor and partner effects are constrained to equality for both individuals, following Kenny, Kashy, and Cook (2006).

Figure 2: Full Model Predicting Cooperation

Note: Paths between all variables were estimated. Only significant paths are displayed. Disturbance terms and correlations among predictors are not displayed. Emotion conditions are compared to neutral. Path estimates for continuous predictors are standardized coefficients. Actor effects represent the actor's role as signaler, whereas partner effects reflect the actor's role as receiver, all estimated within the same model. Actor and partner effects were constrained to be equal for both members of the dyad, following Kenny, Kashy, and Cook's (2006) advice on estimating effects with indistinguishable dyads. Additionally, dyad level effects (gender and emotion condition) were constrained to influence both actor and partner equally.