**Associations Between Daily Positive Communication and Sexual Desire and Satisfaction: A
Comparison Between Traditional Analyses and Machine Learning**

Christine E. Leistner

Department of Public Health and Health Services Administration, California State University,
Chico

Laura M. Vowels

Department of Social and Political Sciences, University of Lausanne, Lausanne, Switzerland
Blueheart Technologies Ltd, London, United Kingdom

Matthew J. Vowels

Department of Social and Political Sciences, University of Lausanne, Lausanne, Switzerland

Kristen P. Mark

Department of Family Medicine and Community Health, University of Minnesota

Author Note

Christine E. Leistner <https://orcid.org/0000-0003-0310-3163>. Twitter: CELeistner

Laura M. Vowels <https://orcid.org/0000-0001-5594-2095>. Twitter: laura_vowels

Matthew J. Vowels <https://orcid.org/0000-0002-8811-1156>. Twitter: matt_vowels

Kristen P. Mark <https://orcid.org/0000-0002-0524-3357>. Twitter: Kristen_Mark

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Correspondence regarding this article should be addressed to Christine E. Leistner, California
State University, Chico, Department of Public Health and Health Services Administration, 400

West First Street, Chico, CA 95929-0505. Email cleistner@csuchico.edu

Abstract

Communication is an important component of many healthy sexual and romantic relationships. Positive communication strategies including expressing fondness and affection, exchanging compliments, and disclosing information about oneself with a partner are associated with relationship and sexual satisfaction, but less is known about its association to sexual desire. Most of the current literature has used traditional statistical analyses that assume errors are normally distributed and that associations between variables are linear. Our study aimed to examine the ways daily levels of four positive communication strategies are associated with relationship satisfaction, sexual satisfaction, and sexual desire among 246 mixed sex couples ($N = 492$). We also compared traditional hierarchical linear modeling with machine learning to compare results from the different data analytic techniques. Findings indicated that daily positive communication received from a partner was associated with all outcome variables of interest that day for both partners in the couple. All positive communication strategies predicted daily levels of desire, sexual satisfaction, and relationship satisfaction for the individual and each had unique associations with partner outcomes. Unique nonlinear interactions were found using machine learning. Findings have implications for practitioners and provide insight into the differences in findings between traditional analyses and machine learning.

Key words: desire, satisfaction, sexual, machine learning, positive communication

Introduction

Communication between romantic partners is an important factor contributing to sexual and relationship health in couples (Hansson & Ahlborg 2016; Leistner & Mark, 2020; Mark & Jozkowski, 2013; Shapiro et al., 2000). While positive communication is associated with more satisfaction and sexual desire in romantic relationships (Leistner & Mark, 2020; Mark & Jozkowski, 2013; McCall & Meston, 2006; Shapiro et al., 2000), negative communication patterns are linked to relationship dissatisfaction and dissolution (Gottman Institute, 2021; Hansson & Ahlborg 2016). However, research in this area tends to focus on communication during conflict situations (e.g., Leuchtmann et al., 2019) and use methodology that assumes errors are normally distributed and traditional analyses that assume linear associations (Vowels, 2021). Given these gaps in the current research, this study aimed to examine the relationship between positive communication (fondness, affection, compliments, intimate disclosure) and satisfaction (sexual and relationship satisfaction) and sexual desire on a daily level among mixed-sex romantic couples. We also compared traditional hierarchical linear modeling with results using machine learning, a non-linear data analysis approach.

Positive Communication and Relationship Satisfaction

Couples that stay together are less likely to report negative communication patterns (e.g., misunderstandings, difficulty expressing feelings, lack of listening) than those who choose to separate (Hansson & Ahlborg, 2016). A large body of literature exists examining associations between communication and relationship satisfaction in couples. In general, findings indicate that positive communication is linked to higher levels of relationship satisfaction (Lavner et al., 2016; Leistner & Mark, 2020; Shapiro et al., 2000; Yoo et al., 2014). For the purposes of this study, positive communication encompasses four interconnected communication strategies

including expressing fondness, intimate disclosure, physical/emotional affection, and exchanging compliments (Doohan & Manusov, 2004; Gottman Institute, 2021, Gottman & Silver, 2015; Sanford, 2006).

According to the Gottman Institute (2021), expressing fondness is linked to more satisfied romantic relationships and has been shown to buffer against the negative impact of transitioning into parenthood on relationship satisfaction for couples (Shapiro et al., 2000). One way that couples may express fondness is through offering emotion-focused compliments. When couples are asked about the best compliments received out of various types including those focused on appearance, performance, and personality traits, couples highlight emotion-focused compliments that are directly related to the relationship (e.g., “you are the best thing that has ever happened to me”). The frequency of exchanging compliments is associated with higher levels of relationship satisfaction for romantic couples and both men and women report valuing and recognizing the importance of compliments in the relationship (Doohan & Manusov, 2004). However, some research suggests that women may be more aware than men on a day-to-day presence of compliments between partners (Doohan & Manusov, 2004).

Exchanging physical and/or emotional affection between partners is also a common positive communication strategy. For couples, physical affection including massage, kissing, and cuddling is associated with higher levels of satisfaction with a romantic partner and the relationship as a whole, and it helps couples to better cope with conflict (Gulledge et al., 2003). On the daily level, physical affection is associated with more positive emotions experienced that day for men and women in romantic couples (Debrot et al., 2017). Taken further, physical affection is associated with daily levels of relationship satisfaction among women reporting genito-pelvic pain on days with and without sexual activity (Vannier et al., 2017). Some research

suggests that affection is an individual trait in which some people consider themselves to be “affectionate” people and others do not (Pauley et al., 2014). This research indicates that affection as a trait is associated with expressing fondness and overall positivity toward a partner, openness in the relationship, planning for the future, sharing responsibilities, and sharing a close social network with romantic partners (Pauley et al., 2014).

Another important component of positive communication is intimate disclosure (Gottman & Silver, 2015; MacNeil & Byers, 2009). When couples have a “love map” or intimate knowledge of their partners’ experiences and life, they are more likely to cope with conflict and be in a thriving relationship (Gottman & Silver, 2015; MacNeil & Byers, 2009). When women self-disclose intimate information about their sexuality and other non-sexual topics, they have higher levels of satisfaction in their relationships (MacNeil & Byers, 2009). For men, non-sexual self-disclosure is related to more satisfaction in the overall relationship (MacNeil & Byers, 2009). Therefore, there may be some interesting differences between men and women in terms of the ways in which positive communication impacts sexual outcomes such as desire and satisfaction versus overall relationship outcomes.

Positive Communication and Sexual Desire and Satisfaction

There are a variety of studies examining associations between positive communication and sexual outcomes such as desire and satisfaction. In general, positive communication is associated with higher levels of sexual satisfaction for both partners in the couple (Leistner & Mark, 2020; Mark & Jozkowski, 2013; Yoo et al., 2014). Yoo and colleagues (2014) measured communication by asking several questions about a partner’s behavior during conflict. Results indicated that for men, better partner communication was associated with higher levels of sexual

satisfaction for self and for their partners. For women, better partner communication was associated with higher levels of their own sexual satisfaction, not satisfaction of their male partner (Yoo et al., 2014). Similarly, a study conducted by Schoenfeld and colleagues (2017) in which men and women were asked about their partner providing affection and compliments reported that men's positive communication was associated with the couple's higher sexual frequency but not their partners' sexual satisfaction. In contrast, women's positive communication was associated with their male partners' higher levels of sexual satisfaction (Schoenfeld et al., 2017). For women experiencing genito-pelvic pain, exchanging physical affection (kissing and hugging) with a partner is associated with higher levels of sexual satisfaction and overall sexual functioning on any given day regardless of sexual activity (Vannier et al., 2017).

Other research suggests that positive communication is related to higher levels of sexual satisfaction for both men and women and for their partners (full partner effects; Leistner & Mark, 2020; Mark & Jozkowski, 2013). Among parenting couples, this association was found to have full actor- (one's own appraisal of partner communication was associated with their own sexual satisfaction) and partner- (one's own appraisal of partner communication was associated with their partner's sexual satisfaction) effects (Leistner & Mark, 2020). Mark and Jozkowski (2013) reported that couple communication was associated with relationship satisfaction and sexual satisfaction for both men and women in the couple (Mark & Jozkowski, 2013). Interestingly, other findings indicate that while communication and sexual satisfaction were separate predictors of marital satisfaction, when couples had high levels of effective communication, the association between sexual satisfaction and relationship satisfaction was not significant (Litzinger & Gordon, 2005).

Few studies have examined the relationship between positive communication and sexual desire. Willoughby et al. (2014) reported that positive communication was associated with higher levels of sexual engagement (sexual desire and frequency) and lower levels of couple desire discrepancies (differences in desire between partners). Other studies measure specific positive communication strategies including intimate disclosure and affection. In a qualitative study, women describe positive self-disclosure between partners as a key factor that promotes intimacy and emotional closeness (Murray & Milhausen, 2012). When partners are engaged during women's self-disclosure, women report having higher levels of dyadic sexual desire (desire for that partner; McCall & Meston, 2006). Further, daily levels of physical affection have been found to mediate the relationship between the couples' sexual frequency and increases in positive emotions for men and women in the relationship (Debrot et al., 2017). Taken together, it is likely that positive communication that includes expressing fondness and affection, exchanging compliments, and disclosing intimate information about oneself with a partner are positively associated with sexual outcomes for couples.

Traditional Analytical Approaches and Machine Learning

Previous research has been analyzed primarily using traditional linear models which are often limited to the estimation of linear associations, or non-linear associations that have been prespecified. Machine learning algorithms have key advantages over these models. Namely, they can learn highly non-linear relationships between variables and estimate complex interactions between different variables. As such, they are not susceptible to cancellation and suppression effects, multicollinearity, or functional form misspecification (e.g., expecting an association to be linear while the real relationship is cubic; Vowels, 2021). Because of this, using machine learning provides a much more flexible and powerful approach to predicting an outcome.

Researchers studying relationships have recently begun using machine learning models which have been applied to better understand predictions of attraction (Joel et al., 2017), relationship satisfaction and commitment (Joel et al., 2020), and sexual desire (Vowels et al., 2021). In the present study, we used both traditional analyses (hierarchical linear modeling) and machine learning models (random forests as well as an ensemble of models) to compare the explanatory power of these different models.

Furthermore, machine learning models have traditionally been “black boxes” insofar as it is not easy to understand what the algorithm has used to make a prediction. Recently, researchers have begun developing ways to interpret the results by providing explanations of machine learning models (Lundberg et al., 2017, 2019). These explainability tools allow researchers to use powerful machine learning algorithms that can more accurately represent the true underlying data structure while still being able to understand which factors contribute to the outcome and by how much. In the present study, we take advantage of this new development in machine learning by using Shapley values (Lundberg et al., 2017, 2019) to estimate how much different facets of positive communication change the model outcomes.

Current Study

There are a variety of ways positive communication has been measured in the past, resulting in some difficulty generalizing the literature. Many studies have focused on communication during conflict (e.g., Gottman Institute, 2021; Leuchtmann et al., 2019; Seiter et al., 2019), others vary in the types of questions they use to operationalize positive communication (e.g., Lavner et al., 2016; Markman et al., 2010; Schmidt et al., 2016), and few studies have examined associations between communication and sexual outcomes on a daily level. The current study is based on past research about key positive communication strategies

including expressing fondness, providing emotional and/or physical affection, sharing intimate details about oneself, and providing compliments. Understanding the ways couples use these specific communication strategies and the implications for daily sexual and relational outcomes can offer insight to inform couples and sex therapists, sex educators, and other practitioners working with couples. It may also offer more insight into the ways researchers should measure positive communication in future work. We used machine learning and traditional hierarchical linear modeling to examine associations between the four types of daily positive communication and sexual desire, sexual satisfaction, and relationship satisfaction over a 30-day period, which may also provide insight into analytic methodology. Specifically, we aimed to answer the following research questions:

R1: Are daily levels of positive communication associated with higher levels of sexual desire, sexual satisfaction and/or relationship satisfaction?

R2: What aspects of daily positive communication are more strongly associated with sexual desire and satisfaction (sexual and/or relationship)?

R3: Do traditional analyses techniques and machine learning analyses techniques exhibit similar results?

Methods

Participants

There were a total of 246 mixed-sex couples ($N = 492$ individuals) who had completed at least two days of the daily diary and were thus included in the final analyses. Majority of the participants were cis-gender ($n = 490$ [99.6%], one identified as transgender) and white ($n = 437$,

88.8%; 5.1% American/Canadian Indian or Alaska Native; 1.8% Asian or Asian American; 2.8% Black or African American). All participants were either married ($n = 418$, 85.0%) or cohabiting ($n = 67$, 13.6%), most had at least some level of college (91.9%), identified as Christian (61.0%, 20.3% did not identify with a specific religion), and heterosexual ($n = 447$; 90.8%; 5.7% were bisexual/pansexual). The average age was 30.93 years ($SD = 4.86$, range = 21-50) and the average relationship length was 7.67 years ($SD = 3.67$, range = 3-20).

Procedures

Participation in the current study included completing a baseline questionnaire (30-45 minutes) and then a 30-day daily diary (5-15 minutes per day). Participants were eligible to participate if they were living in the United States (US), 18 years of age or older, currently living with a romantic partner they had been with for three or more years and reported engaging in sexual activity at least once per month. All female partners were required to be premenopausal to alleviate menopause as a confounding variable and all mothers were required to have given birth six weeks or longer from the time of the study to adhere to medical guidelines for safe resumption of sexual activity after childbirth (Mayo Foundation for Medical Education and Research, 2016). The study was approved by the internal review board (IRB) at a mid-sized institution in the United States.

To recruit participants using convenience sampling, a link to an information webpage for the study was posted to social media (e.g., Facebook, Twitter), in addition to targeted recruitment techniques including posting on couple-specific pages and listservs. Recruitment also included a Public Service Announcement through a local radio station and displaying posters on the university campus and in the surrounding community (e.g., cafes, libraries). A database was

designed specifically for the study so participation in the daily diary was simple and partners' data were internally connected to keep the dyad together for analysis. Interested participants followed the survey link to an initial sign-in page and consent form. If a participant consented to participate, they created a username and password for the online database connected to the survey. When one partner in a couple completed the initial process, they were assigned an individual unique identification number and asked to provide their partners' email address. Their partner was automatically sent an invitation to participate. This process connected each individual in the couple and assigned each couple a unique identification number. Participants could leave questions blank and/or discontinue the survey at any time. After completing the baseline survey, participants were sent notifications each day about completing the daily portion of the survey. This daily survey took 5-15 minutes depending on whether the couple was sexually active that day. Upon completion of the baseline survey, all participants received a \$10 Amazon gift card. Upon completion of the 30-day daily diary portion of the study, participants received an additional \$20 Amazon gift card (\$40 per couple). Once participants completed the study, all data were stored in a password secured location. Survey data were only managed and analyzed by the proposed study primary investigators and additional researchers hired specifically for the proposed study data analyses.

Measures

At baseline, demographic information such as age, relationship length, and gender identity were collected. Each day, participants were asked whether they engaged in sexual activity with their partner. They were also asked a variety of questions related to their sexual and relational health. Several sexual and relational health constructs were measured; below we outline the measures that were collected relevant to the current paper.

Daily Positive Communication

Positive communication was measured with four items that measured fondness, compliments, affection, and disclosure received from a partner on a given day. These items were developed based on previous research on general positive communication (see Leistner & Mark, 2020) and were adapted to ask about these experiences each day. For example, “During the past day, to what degree did your partner express fondness toward you?” was asked to measure fondness with response options on a 5-point scale ranging from “never” to “very much” with higher scores indicative of more positive communication.

Daily Sexual Satisfaction

Daily sexual satisfaction was measured with the following item: “During the past day, how sexually satisfied did you feel?” Response options were on a 5-point scale ranging from “not at all sexually satisfied” to “extremely sexually satisfied” with higher scores indicative of higher daily sexual satisfaction.

Daily Relationship Satisfaction

Daily relationship satisfaction was measured with the following item: “During the past day, how relationally satisfied did you feel?” Response options were on a 5-point scale ranging from “not at all relationally satisfied” to “extremely relationally satisfied” with higher scores indicative of higher daily relationship satisfaction.

Daily Sexual Desire

Daily sexual desire was measured with the following item: “During the past day, did you feel desire for your partner?” Response options were on a 5-point scale ranging from “not at all” to “extremely” with higher scores indicative of higher daily sexual desire.

Data Analysis

Traditional Statistical Analysis

Data were analyzed using hierarchical linear modeling (Raudenbush & Bryk, 2002) that treats three levels of indistinguishable dyadic daily diary data (days nested within individuals nested within couples) as two levels of random variation. The level-1 represents within-person repeated measures variability for male and female partners, and level-2 represents between-couples variability across male partners and across female partners (see Laurenceau & Bolger, 2005 for more detail). We estimated two models for each outcome: one with the total communication scale and one with the subscales separately. We employed the Actor-Partner Interdependence Model with hierarchical linear modeling that allowed us to simultaneously estimate both actor and partner effects (Kenny, 1996; Kenny et al., 2006). Actor effects refer to paths that predict one person’s outcome from their own predictor variable whereas partner effects refer to paths that predict one person’s outcome from their partner’s predictor variable. We used the *nlme* package in *R* to estimate the model. All available data were included in the models and missing data were handled using *Restricted Maximum Likelihood* (REML). We included the random effects in the models with the total communication scale. The model with full random effects for sexual desire did not converge and thus we removed partner’s total communication from the random effects model. We only included intercept and time in the random effects for the models with subscales because the model had too many predictor

variables for the models to converge with full random effects. We estimated the models including age and gender as control variables.

Machine learning analyses

We implemented two types of machine learning techniques (random forests with Shapley values on pooled data as well as a stacked ensemble over the longitudinal data). We first followed a random forest with Shapley values on pooled data approach (for details on this approach, see Vowels et al., (2021)). Data were analyzed using a random forest regressor (Breiman, 2001) in Python 3.7. A random forest is a type of decision tree that trains on bootstrapped sub-samples of the data to avoid overfitting. By selecting multiple random subsets of predictors, the algorithm recursively partitions the input space to maximize its predictive power on a randomly selected *out of bag* sample (i.e., a sample that the model has not seen before). The use of this out of bag sample is what helps to mitigate overfitting during the training process. By undertaking this partitioning and out of bag sample testing thousands of times (i.e., by bootstrapping), the random forest can derive the best ‘average’ decision tree for the training data. The tree can model highly non-linear relationships in the data, and therefore represents a significantly more flexible model than a linear regressor. A ten-fold cross-validation scheme was used to train and test the model. This means the total dataset is randomly split into ten equally sized folds. The model is trained on nine out of ten folds, tested on the tenth, and the test fold performance is recorded. This is repeated until all ten folds have been used as a test set. The average performance as well as the standard error across the ten folds, provide an estimate of model performance on unseen data.

Because random forests do not readily support hierarchical time series data, we took the pooled data across the timepoints for each variable for each participant and used them as

predictors for the mean level of the outcome variable. This provided an estimate of the average positive communication, sexual and relationship satisfaction, and sexual desire over a period of a month. Because we wanted to also understand how predictive the different positive communication subscales were, we used Shapley values to provide an ‘explanation’ of the random forest algorithm output. Thus, the last trained model from the random forest was saved and interpreted using the “SHapley Additive exPlanations” package (SHAP; Lundberg et al., 2017; 2019; 2020). The SHAP package is a unified framework for undertaking model explanation and has been shown to be more reliable than using random forest model importances (Lundberg et al., 2017; 2019; 2020). By combining powerful and flexible machine learning algorithms like the random forest with the SHAP method, we were able to *project* the predictors into an interpretable space for subsequent model explanation. Specifically, we used the SHAP *TreeExplainer* package, which provides estimations of the per-individual, per-predictor impact on model output, as well as the average predictor impacts. For the analysis the default settings of the SHAP package *TreeExplainer* were used, and the entire dataset was fed to the model for explanation.

For the second part of the machine learning analyses, we estimated the predictive capacity of positive communication over time. We used ten days of data from each participant (we did not expect that there would be a lag of over ten days) to predict the last day. We included participants who had at least ten consecutive lags with no more than two missing data points. This left us with 103 couples and 17% of missing data which were imputed using Bayesian ridge imputation. The models were run using first just the same day and increasing the lags one at a time to up to ten lags. We trained the model using 10-fold cross validation and estimated the model performance by recording the R^2 with each additional lag. We also examined whether the

model performance differed over the lags when the same day predictor was not included in the model.

Utilizing the *sklearn StackingRegressor* package (Wolpert, 1992) we implemented a 'stack' of estimators with a 'final estimator'. Stacking is a method whereby the predictions from a prespecified set of models are fed into a final model to yield the final prediction. The benefit of stacking is that it circumvents the need to identify the best model across a set of possible candidates by combining the predictions from multiple models simultaneously. Such a method can sometimes work synergistically to not only reduce the need for exhaustive model search, but also to yield a performance exceeding that of the best model by itself. We trained the final estimator using nested five-fold cross validation (nested in the sense that it uses the training fold from the outer cross-validation loop). The stack of estimators we used included a linear ridge regressor (Hoerl, 1970), a linear lasso regressor (Tibshirani, 1996), a k-nearest neighbours regressor (Altman, 1992) (number of neighbours set to 20), and a random forest regressor (Breiman, 2001) (default settings as with the Shapley experiments). The final estimator was a gradient boosting regressor (Friedman, 1999).

Results

Traditional Analysis Results

There were a total of 6416 observations from 246 dyads that were included in the analyses. Because we had three outcome variables, we used a Bonferroni corrected alpha level of .0167 (.05/3). We first examined whether the total positive communication scale positively predicted sexual and relationship satisfaction and sexual desire (see *Table 1* for the full results). Both actor and partner's positive communication significantly predicted all outcome variables

(all $ps < .001$). The R^2 was .41 for sexual satisfaction, .47 for relationship satisfaction, and .29 for sexual desire. Similarly, each positive communication subscale significantly positively predicted all outcome variables (all $ps < .001$; see *Table 2* for the full results). However, partner's positive communication subscales were less consistently predictive of the actor's outcomes: Partner's fondness predicted all outcomes; partner's compliments were significantly predictive of relationship satisfaction and sexual desire but not sexual satisfaction; partner's affection significantly predicted sexual satisfaction and sexual desire, but partner's sharing did not significantly predict any outcome variables. The R^2 was .43 for sexual satisfaction, .47 for relationship satisfaction, and .33 for sexual desire.

[*Table 1* about here]

[*Table 2* about here]

Machine Learning Analysis Results

First, we ran the analyses using the pooled scores for the predictor and outcome variables. The R^2 using the random forest algorithm were higher compared to the multilevel model results: .46 for sexual satisfaction, .64 for relationship satisfaction, and .47 for sexual desire. *Figure 1* (a-c) shows the order of the positive communication subscales in predicting the outcome variables. The figure provides the estimates for each individual participant. Red indicates a higher value of the predictor variable and blue indicates a lower value. For example, red is equal to 1 and blue is equal to 0 for binary variables. Both actor and partner's reports of positive communication were predictive of the outcomes but none of the positive communication subscales consistently predicted all outcomes. In fact, the affection subscale and compliments were the highest predictors of sexual satisfaction, both actor and partner's fondness for relationship satisfaction,

and compliments for sexual desire. Overall, the positive communication subscales, higher scores predicted an increase in the outcome whereas lower scores predicted a decrease. Age was also an important predictor of sexual desire in that younger people reported higher sexual desire compared to older people. However, age impacted the model output less for sexual and relationship satisfaction.

[*Figure 1* about here]

In addition to examining the importance's of each predictor variable on the outcomes, the random forest algorithm also examined any potential interactions between the variables. There were several potential variables that showed some interaction and we have included the strongest interactions, one for each outcome variable. There was a non-linear interaction between actor's perception of partner's compliments and actor's perception of partner's affection for sexual satisfaction (*Figure 1d*). For very low scores on both compliments and affection, the effect was less clear and for low to moderate levels of both compliments and affection there was no change in sexual satisfaction. For high levels of both compliments and affection the interaction predicted a decrease in sexual satisfaction for most participants. However, there was a subsample of participants for whom having a lot of compliments and affection increased sexual satisfaction. This finding suggests that for some people high levels of compliments and affection positively predict sexual satisfaction but for others high levels of compliments and affection actually predict lower sexual satisfaction.

For relationship satisfaction, there was an interaction between the actor's perception of partner's affection and actor's perception of partner's fondness (*Figure 1e*). The results showed that relationship satisfaction was higher at both low and high levels of simultaneous affection

and fondness. In other words, when both affection and fondness were high or low at the same time, these were both positively predictive of relationship satisfaction. However, at moderate levels of both affection and fondness, the algorithm predicted a lower relationship satisfaction for some people and no change for others.

There was also a partner interaction between partner's age and partner's perception of actor's affection, which predicted actor's level of sexual desire (*Figure 1f*). For older partners, when they reported that the actor was higher in affection, the actor themselves reported higher sexual desire. However, when the older partners reported that the actor was lower in affection, the actor themselves reported lower sexual desire. In contrast, this relationship was the opposite for younger people in that for younger partners who perceived the actor as more affectionate, the actors reported lower desire and when younger partners perceived the actor as less affectionate, the actors reported higher levels of sexual desire.

[*Figure 2* about here]

For longitudinal analyses, we used up to ten lags to predict the outcome variable at the last time point. We used the separate subscales for the positive communication as predictors. When the same day predictors were included in the model (*Figure 2*), adding additional lags did not show an overall improvement in the predictive ability of the outcome variable. However, when the same day predictor variable was removed (*Figure 3*), adding additional lags improved the model's predictive ability for all outcome variables. In other words, the same day positive communication is the most predictive of same day sexual and relationship satisfaction and sexual desire. However, in the absence of access to the same day reports, having more lags (i.e., more information) can improve the estimate of the outcome.

[Figure 3 about here]

Discussion

The current study sought to understand the associations between daily levels of positive communication and sexual desire, sexual satisfaction, and relationship satisfaction among mixed sex couples. We also compared traditional hierarchical linear modeling with machine learning to examine differences in the outcomes of these two analytical approaches. One overarching finding was that both traditional and machine learning analyses reported that positive communication (fondness, affection, disclosure/sharing, and compliments) was associated with all daily outcomes of interest for individuals and their partners. In other words, when individuals reported higher levels of total positive communication received from their partner on a given day, they had higher levels of relationship satisfaction, sexual satisfaction, and sexual desire on that day, as did their partner. Overall, we found that machine learning models were able to explain more variance in the outcomes compared to the traditional linear models suggesting that there was non-linearity and interactions between the variables that were not accounted for in the linear models.

We also found significant associations for specific types of positive communication and nuanced differences between traditional versus machine learning analyses. For example, results from traditional linear modeling indicated that fondness received from a partner was associated with higher levels of all outcomes of interest (sexual desire, sexual satisfaction, and relationship satisfaction) for individuals (actor effects) and their partners (partner effects). Machine learning analyses highlighted that individual and partner fondness was the strongest predictor of

relationship satisfaction. This is aligned with a large body of past research (Gottman Institute, 2021; Shapiro et al., 2000).

According to the traditional model results, receiving affection from a partner was associated with daily levels of all outcomes of interest for the individual (full actor effects) and sexual satisfaction and sexual desire (not relationship satisfaction) for partners (partial partner effects). The machine learning modeling analysis highlighted that receiving affection from a partner was one of two strongest predictors of sexual satisfaction (along with receiving compliments). However, for those receiving low levels of affection from a partner, the association with sexual satisfaction was not as clear. Therefore, this finding is likely most relevant for those with high levels of affection. According to the machine learning results, there were also interactions between fondness and affection such that when individuals had high levels of both types of communication, they had high levels of relationship satisfaction. However, for those with mid-levels of fondness and affection, the association was more unclear. This adds important information about couples and the ways that these communication strategies interact with one another. These results align with prior research suggesting that some individuals are “affectionate” people (as a trait not behavior) and others are not as affectionate and may not value affection as highly (Pauley et al., 2014). This past research indicates that affection, as a trait, is associated with other positive communication behaviors including expressing fondness toward a partner (Pauley et al., 2014) which is aligned with what we found through machine learning analyses. More research is needed to further understand the interaction between fondness and affection, how it is associated with satisfaction and whether this association is true across levels of communication and satisfaction among couples.

Receiving affection from a partner was also related to sexual desire on the daily level. We asked participants about emotional and physical affection and it may be that both contribute to daily levels of desire for couples. This finding is aligned with past research indicating that women frequently identify emotional closeness and intimacy as objects of desire (Mark et al., 2014) and couple levels of affection predict sexual desire for women (Carvalho & Nobre, 2010). Interestingly, for sexual desire, findings depended on age in our study. We found that older people perceived their partners as more affectionate when their partners reported higher levels of sexual desire and less affectionate when their partners reported lower levels of sexual desire. This relationship was reversed for younger individuals (in their 20's) such that younger people perceived their partners as less affectionate when the partners had higher levels of desire and more affectionate when their partners had lower levels of desire. This finding is interesting and suggests that perhaps sexual desire is expressed or communicated differently at different ages. Future research is needed to more fully understand why this might be the case. Past research has highlighted that age is related to lower levels of sexual desire in later life for women and men (DeLatamer & Sill, 2005), but there are few studies examining the interactions between age, affection and sexual desire on a daily level.

Traditional analyses results indicated that receiving compliments from a partner was associated with daily levels of all variables of interest for the individual (full actor effects) and relationship satisfaction and sexual desire (not sexual satisfaction) for their partner (partial partner effects). The association with compliments and sexual desire on the daily level is interesting and may speak to the ways that individuals want to be the object of their partner's desire, especially women (Mark et al., 2014). These findings are aligned with previous work indicating that couples experience more daily sexual desire on days when they have more

positive relationship events (e.g., partner providing compliments, expressing love, enjoyable activities together, feeling wanted by partner, sharing laughter; Impett et al., 2008). Interestingly, results from the machine learning analysis indicated that receiving compliments was a strong predictor of sexual satisfaction and sexual desire. We also found interactions between compliments and affection for sexual satisfaction among some participants. For those with high levels of both compliments and affection, we found non-linear effects. For some couples, high levels of both compliments and affection predicted higher levels of sexual satisfaction whereas for other couples, these high levels of both compliments and affection predicted lower levels of sexual satisfaction. Perhaps this can partially be explained by the types of compliments that partners were receiving. For example, Doohan & Manuscov (2004) found that emotion-focused compliments were related to more relational satisfaction for couples. However, it could be that specific types of compliments are related to sexual satisfaction and some are not; more research is needed in this area. Recent work has highlighted that there are differences in outcomes between sexual communication and overall communication between couples (Jones et al., 2017) and the same may be true for exchanging compliments. Therefore, sexually-related compliments may impact sexuality more than general compliments. More research is needed to understand this further. These nuanced findings are interesting and may also speak to the ways in which some couples value specific forms of communication more than others. Perhaps this could be due to a person's love language in which some value words of affirmation and others value acts of service or gifts (Bland & McQueen, 2018). More research is needed to understand why the interaction between high levels of compliments and affection is associated with lower levels of sexual satisfaction for some couples and higher levels for others.

According to the traditional model results, reporting that a partner disclosed something intimate that day was associated with all outcomes of interest for the individual on a daily level (full actor effects), but not any of the outcomes of interest for their partner (no partner effects). This finding speaks to the importance for individuals in relationships in which their partner shares information about their life. The Gottman Institute (2021) has documented the importance of understanding your partner's love maps, or knowing intimate details about your partner, in terms of developing and maintaining a healthy romantic relationship. Our research suggests that this is true for individuals on a daily level to the extent that when an individual perceives their partner disclosing intimate details about their life in a positive way, that individual has higher levels of sexual desire, sexual satisfaction, and relationship satisfaction. However, this does not seem to translate into the partner having higher levels of satisfaction or desire in our study. Past research indicates that couples perceive disclosing private details about their lives and being understood by one's partner on a daily level as intimate experiences (Lippert & Prager, 2001). It may be that even though the individual receives high levels of disclosure from their partner on a given day, their partner may not perceive them as responding well, understanding them, or being attentive to them during the disclosure, and therefore this disclosure may not influence the partner's level of satisfaction or desire. More research is needed to understand the ways that the disclosure is interpreted by both partners in the couple and how these interpretations are associated with satisfaction and desire on a daily level.

Limitations and Future Directions in Research

The machine learning analysis highlighted that even though we found general trends in which positive communication (and individual subscales) was positively associated with outcome variables of interest, this was not always the case for every couple. These findings

suggest that there are likely nuances in which some couples may have other components of their relationship that influence their desire and satisfaction to a greater extent than communication. For example, Litzinger and Gordon (2005) found that communication and sexual satisfaction were separate predictors of relationship satisfaction; if couples were not good at communicating, but were sexually satisfied, they still maintained high levels of relationship satisfaction. This research suggests an important role in maintaining sexual satisfaction over time for couples and sexual well-being may be particularly important for some couples in maintaining their overall relationship health and quality.

It is likely important to understand what is going on with couples in “the middle” or “low” levels of communication, satisfaction and desire where we found that the effects of positive communication were not as pronounced. We did not measure negative communication, which may interact with desire and satisfaction in different ways than positive communication. Schoenfeld and colleagues (2017) found that couples with more affectionate male partners and more negatively communicating female partners had higher levels of sexual frequency. This finding suggests that there could be interactions between negative and positive communication and gender for mixed sex couples that were not captured in our study. Schoenfeld et al. (2017) found that both positive (measures include: saying I love you, engaging in physical affection, and expressing approval or offering compliments), and negative (measures include: dominating conversations, showing anger or impatience, and purposefully doing something to annoy one’s partner) communication strategies/styles were associated with sexual and relationship satisfaction for the individual and their partner in the couple context (Schoenfeld et al., 2017). These associations were in the expected direction where more positive communication was linked with higher levels of satisfaction and more negative communication was linked with

lower levels (Schoenfeld et al., 2017). Perhaps the negative communication patterns add new interactions that could capture what is happening with some of the couples in our study and future researchers may benefit from including both or more complicated communication measures.

Research has found that positive communication and satisfaction in relationships are closely correlated and the associations between these variables may be artificially inflated due to shared method variance on the same day. We attempted to address this by also examining the lagged effects of positive communication on the outcome variables. Indeed, we did find that when the same day positive communication was included in the models, previous time-points added no additional explanatory power to the models. However, when the same day positive communication was not included in the models, the previous day's positive communication was less related to the following day's outcomes. With additional data-points it was possible to improve the predictive ability of previous time-points suggesting that with enough data, it is possible to provide an average level of positive communication that is relatively predictive (although much less) of the outcome.

Additionally, positive communication has been measured in a number of ways and it is difficult to summarize findings at times. One strength of the current study is that we examined each communication strategy separately to understand associations between each specific strategy with outcomes of interest on a daily level. Future research would benefit from measuring specific strategies separately to understand how they are related to sexual and relational health so that we can identify new strategies that may be beneficial for couples and strengthen our measures for future studies.

Finally, our study included mixed sex couples that were primarily white, educated, and heterosexual. More research is needed to understand how positive communication is associated with satisfaction and desire among more diverse samples of couples.

Implications and Conclusions

Understanding how communication is associated with daily levels of sexual desire and satisfaction and relationship satisfaction have real implications for couples and those working with couples. In general, positive communication is good for sexual and relational health among mixed sex couples. However, with machine learning techniques, we were able to identify non-linear findings that offer nuanced information about who these strategies work for and insight into new areas of research. Though we found general positive associations between positive communication and all outcome variables of interest, there were exceptions for those couples with moderate to low levels of these communication patterns. This information suggests that there are likely other important variables in the relationship that were missing from this study and these strategies may work for many but not all couples. Through the use of machine learning and the comparisons between traditional modeling and machine learning, we were able to capture differences in our results that offer insight into and support for the use of non-linear modeling techniques such as machine learning to capture a fuller picture of associations in our data. Future research may benefit from incorporating machine learning and these comparisons when designing new studies.

Declaration of Interest: We have no conflicts of interest to declare.

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Table 1

The Results for the Total Positive Communication Scale Predicting Sexual and Relationship Satisfaction and Sexual Desire

<i>Predictors</i>	Sexual Satisfaction			Relationship Satisfaction			Sexual Desire		
	<i>Estimates</i>	<i>CI</i>	<i>p</i>	<i>Estimates</i>	<i>CI</i>	<i>p</i>	<i>Estimates</i>	<i>CI</i>	<i>p</i>
(Intercept)	3.29	2.85 – 3.74	<0.001	3.01	2.64 – 3.38	<0.001	3.83	3.37 – 4.30	<0.001
Communication actor	0.71	0.65 – 0.77	<0.001	0.64	0.60 – 0.69	<0.001	0.52	0.46 – 0.57	<0.001
Communication partner	0.26	0.21 – 0.31	<0.001	0.18	0.14 – 0.22	<0.001	0.16	0.13 – 0.19	<0.001
Age actor	0.02	0.01 – 0.03	<0.001	0.00	-0.00 – 0.01	0.270	0.01	-0.00 – 0.02	0.273
Age partner	-0.03	-0.04 – -0.02	<0.001	0.01	0.00 – 0.02	0.016	-0.02	-0.03 – -0.01	<0.001
Gender (man = 1)	-0.05	-0.09 – -0.00	0.040	-0.00	-0.04 – 0.03	0.929	0.40	0.35 – 0.44	<0.001
Time	-0.00	-0.00 – 0.00	0.498	0.00	-0.00 – 0.00	0.490	-0.00	-0.01 – -0.00	<0.001
Random Effects									
σ^2	0.68			0.35			0.65		
τ_{00}	0.17	couple_id		0.17	couple_id		0.24	couple_id	
τ_{11}	0.10	couple_id.ccomm_a		0.05	couple_id.ccomm_a		0.06	couple_id.ccomm_a	
	0.05	couple_id.ccomm_p		0.03	couple_id.ccomm_p		0.00	couple_id.ranges	
	0.00	couple_id.ranges		0.00	couple_id.ranges				
ρ_{01}	-0.06			-0.01			-0.23		
	0.13			-0.43			-0.02		
	0.30			-0.21					

ICC	0.31	0.38	0.33
N	236 couple_id	236 couple_id	236 couple_id
Observations	6305	6416	6414
Marginal R ² / Conditional R ²	0.406 / 0.592	0.469 / 0.668	0.292 / 0.525

Note. Age, gender, and time were included as control variables.

Table 2

The Results for Each Positive Communication Subscale Predicting Sexual and Relationship Satisfaction and Sexual Desire

<i>Predictors</i>	Sexual Satisfaction			Relationship Satisfaction			Sexual Desire		
	<i>Estimates</i>	<i>CI</i>	<i>p</i>	<i>Estimates</i>	<i>CI</i>	<i>p</i>	<i>Estimates</i>	<i>CI</i>	<i>p</i>
Intercept	3.32	2.88 – 3.75	<0.001	2.92	2.54 – 3.29	<0.001	4.00	3.53 – 4.48	<0.001
Positive Communication actor									
Fondness	0.17	0.13 – 0.20	<0.001	0.24	0.22 – 0.27	<0.001	0.17	0.13 – 0.20	<0.001
Compliments	0.17	0.13 – 0.20	<0.001	0.08	0.05 – 0.10	<0.001	0.07	0.04 – 0.10	<0.001
Affection	0.32	0.28 – 0.36	<0.001	0.21	0.19 – 0.24	<0.001	0.22	0.19 – 0.25	<0.001
Sharing	0.09	0.06 – 0.12	<0.001	0.15	0.13 – 0.17	<0.001	0.11	0.08 – 0.14	<0.001
Positive Communication partner									
Fondness	0.07	0.03 – 0.10	0.001	0.05	0.03 – 0.08	<0.001	0.07	0.04 – 0.11	<0.001
Compliments	0.03	-0.00 – 0.06	0.084	0.04	0.01 – 0.06	0.003	0.04	0.01 – 0.07	0.004
Affection	0.13	0.09 – 0.17	<0.001	0.01	-0.02 – 0.04	0.425	0.06	0.03 – 0.10	<0.001
Sharing	-0.00	-0.03 – 0.03	0.953	0.01	-0.01 – 0.03	0.496	-0.03	-0.06 – -0.00	0.029
Age actor	0.02	0.01 – 0.03	<0.001	0.01	0.00 – 0.02	0.043	0.01	-0.00 – 0.02	0.290
Age partner	-0.03	-0.04 – -0.02	<0.001	0.01	0.00 – 0.02	0.028	-0.03	-0.04 – -0.02	<0.001
Gender (man = 1)	-0.05	-0.09 – -0.00	0.036	-0.01	-0.05 – 0.02	0.455	0.41	0.37 – 0.46	<0.001

Time	-0.00	-0.00 – 0.00	0.457	0.00	-0.00 – 0.00	0.173	-0.01	-0.01 – -0.00	<0.001
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Random Effects

σ^2	0.72		0.37		0.66
τ_{00}	0.16 couple_id		0.17 couple_id		0.24 couple_id
τ_{11}	0.00 couple_id.ranges		0.00 couple_id.ranges		0.00 couple_id.ranges
ρ_{01}	0.28 couple_id		-0.31 couple_id		0.03 couple_id
ICC	0.23		0.31		0.30
N	236 couple_id		236 couple_id		236 couple_id
Observations	6305		6416		6414
Marginal R ² / Conditional R ²	0.428 / 0.559		0.473 / 0.635		0.329 / 0.533

Note. Age, gender, and time were included as control variables.

Figure 1

The Shapley Values for Each Predictor Variable and Outcome (a-c) and Interactions Plots for the Strongest Interactions for Each Outcome

Figure 2
Lagged Analyses with Current Day Included

Figure 3
Lagged Analyses with Current Day Excluded