7-2024

Romantic Resilience: Fractal Conflict Dynamics and Network Flexibility Predict Dating Satisfaction and Commitment

David Pincus

Romantic Resilience: Fractal Conflict Dynamics and Network Flexibility Predict Dating Satisfaction and Commitment

Nonlinear Dynamics, Psychology, and Life Sciences, Vol. 28, No. 3, pp. xxx-xxx.

Romantic Resilience: Fractal Conflict Dynamics and Network Flexibility Predict Dating Satisfaction and Commitment

David Pincus,[1] *Chapman University, Orange CA*

Abstract: *Previous research has demonstrated that interpersonal dynamics are fractal, and that conflict is a key control parameter that drives fractal complexity. The present study aimed to extend this line of research to examine the putative fractal structure of conflict dynamics over time, and the role that this self-organizing fractal structure may play in the resilience of romantic relationships. An experience sampling methodology was used to assess levels of conflict, satisfaction, and commitment in the dating relationships of undergraduate students, three times per day for 30 days. Hypothesis 1 was supported, with conflict ratings over time generally conforming to an inverse power-law distribution (IPL) distribution. Hypothesis 2 was supported as well, with better IPL fits (measured as variance accounted for, R^2) predicting higher levels of satisfaction and commitment over the 30 days. Hypothesis 3 showed mixed support, with moderate network linkages (i.e., soft assembly) between conflict and satisfaction and commitment predicting higher IPL fits (the linkage of satisfaction and commitment did not predict IPL fit as predicted). Hypothesis 4 predicted that IPL fit would interact with mean conflict, buffering the impacts of conflict on mean satisfaction and commitment across the 30 days. This hypothesis was not supported; however, several statistical factors may have obscured the buffering effects of higher IPL fit and so results may be inconclusive. These methodological factors, and others, are discussed along with the potential theoretical and practical implications of the current results.*

Key Words: dating, conflict, relationships, resilience, self-organization, inverse power law, fractal, networks

INTRODUCTION

Self-organizing systems have a variety of self-regulating and adaptive features. They emerge through sufficiently complex bottom-up interactions among their component parts, without the need for external or control. They tend to produce fractal behavior, with exponentially more small changes than large ones (Kauffman, 1995). This exponential relationship is consistent across

[1] Correspondence address: David Pincus, Department of Psychology, Chapman University, One University Drive Orange, CA 92866. E-mail: pincus@chapman.edu

different scales of measurement, is fractal in nature (e.g., self-similar), and can be used as an index of relative complexity (Guastello, 2011; Guastello & Liebovich, 2009). Altogether, these combined properties of emergence, complex and malleable interconnectedness among components, fractal structural dynamic outputs, and in particular the capability of adjusting their own levels of coherence and flexibility in response to perturbation may combine to allow self-organizing systems to exhibit self-regulation, adaptation, and the potential for resilience (Kiefer & Pincus, 2023; Pincus & Metten, 2010).

From this theoretical perspective, it has been proposed that self-organizing resilience in biopsychosocial systems rests upon: "…the meta-flexibility of the system: the ability to respond to a perturbation by either becoming rigid and robust, or flexible and fluid without becoming stuck or falling apart respectively." (Pincus & Metten, 2010, p. 359). Imagine a boxer in a heated match, bracing against an opponent's punch, making herself temporarily rigid and robust against the heavy perturbation about to land on her abbs. With good timing, she will hold strong against the blow, and able to quickly loosen up again, perhaps to deliver a counter punch. Alternatively, the boxer may loosen her movements at the outset, delivering her own punch before the opponent's punch can land, or dodging the punch just prior to delivering the counter punch. Boxing is a salient metaphor for the often seamless, yet complex flow of tightening and loosening that a human biopsychosocial system may display in response to a similarly complex flow of challenges in romantic relationships. Just as in the case of the boxer facing punches, a relationship may lose resilience if it gets too tight and stuck, or if it falls apart.

The current investigation is concerned first with whether intimate relationships can be characterized as self-organizing systems. If so, then to what extent do they display an equivalent sort of resilience as more salient physical examples, like the combined physical robustness and flexibility of a boxer? To what extent does the increased rigidity inherent within conflict represent adaptive robustness against perturbations in the flow of conflicting interpersonal information? And might conflict resolution reflect the adaptive flexibility that a healthy conflict can bring forth – whereby relatively large numbers of small conflicts are beneficial for longer-term resilience? For a recent review of this well-known phenomenon in human population dynamics, see Riris et al. (2024).

Resilience

This sort of dynamical resilience, well-timed auto-tuning of one's own levels of robustness and flexibility, depends upon well-integrated, yet flexible flows of information across biopsychosocial networks (Pincus & Metten, 2010; Kiefer & Pincus, 2023). This is a key lens through which to view the underlying mechanics of resilience in a self-organizing system. Referred to in various ways across the branches of science and engineering, this sort of network dynamic has been described as a *soft assembly* of components, *loose ties*, *network flexibility* and others (Kiefer & Pincus, 2023). By contrast, resilience *loss* would hypothetically occur through disconnections among network components, a

process of disintegration, or perhaps not metaphorically when a romantic relationship begins to *fall apart*. Alternatively, or simultaneously in other areas of the system, resilience loss may be observed due to a buildup of lasting rigidity among components resulting in stuckness and inflexibility.

A resilient relationship hypothetically should display a level of network reactivity consistent with a "Goldilocks" effect within their conflicts, equivalent to resilience effects described as optimum variability (Guastello, 2015). If reactivity is too high, one or both partners may become immediately dissatisfied and threaten to end the relationship in response to conflicts. If reactivity is too low, they may not react strongly enough to conflict, displaying apathy, emotional neglect, and low motivation for conflict resolution. If reactivity is "just right," one should observe resilience in response to conflict, with enough reactivity to motivate engagement and resolution, but enough flexibility to buffer positive feedback, escalation, and potential ruptures or break ups.

As a visually salient example, imagine a boxer losing resilience during a fight. The boxer would display a loss of timing, robustness, and flexibility as the connections among the various facets of the perceptual and motor systems become under-reactive, disintegrated, and sluggish. They may also display rigidly over-reactive, tight, stuck, and overly predictable responses. Within an intimate relationship, a couple may similarly lose resilience in their love relations if their conflicts become miss-timed, their commitment becomes fragile, their disagreements become rigid and repetitive, and their emotional responses to one another become rigidly over-reactive, tight, and stuck as in the case of intractable conflicts (Coleman, Vallacher, Nowak, & Bui-Wrzosinska, 2007; Vallacher, Coleman, Nowak, & Bui-Wrzosinska, 2010). This over- or under-reactive model of resilience loss is consistent with the unhealthy relational behaviors most often used to describe the targets of intervention in couples therapy, with defensiveness and stonewalling describing increasingly pervasive under-reactivity, and criticism and contempt representing the over-reactive counterparts, what Gottman refers to as *The Four Horsemen* of marital apocalypse (Gottman, Swanson, & Swanson, 2002).

These self-regulating and resilience-making features of self-organizing systems have been applied to integrative psychotherapy (Pincus, 2015, 2016, 2024) as well, and to various research domains across the gamut of psychological experience. For example, behavioral dynamics have been shown to be fractal, with high levels of behavioral rigidity or incoherence triggering the onset of self-injurious behavior, followed by a shift back to relatively moderate levels of behavioral flexibility and integrity (Pincus et al., 2014). Exercise habits appear to display fractal patterns in time between activity, with an association between high levels of coherence (measured as high temporal *burstiness*) and resistance to a fitness intervention, and low coherence predicting greater behavioral change (Berardi, Pincus, Walker, & Adams, 2021). Similar results have been found in the dynamics of emotion (Schuldberg & Gottlieb, 2002), personality with rigidity in fractal personality organization predicting psychopathology (Pincus, Cadsky, Berardi, Asuncion, & Wann, 2019) and self-esteem (Wong, Vallacher, & Nowak,

2014, 2016), and more closely related to the current study within conversational social dynamics (Pincus, 2001, 2014; Pincus & Guastello, 2005; Pincus, Ortega, & Metten, 2011).

The focus of the current study is to extend prior empirical research targeting social resilience in small groups. Prior research has found that conversation patterns in family therapy sessions (Pincus et al., 2011), a single group therapy session (Pincus & Guastello, 2005), and experimental groups (Pincus, 2014) are typically fractal. Specifically, when examining the recurrence structure underlying turns at speech, it turns out that a high degree of patterning emerges. Of the great variety of possible patterns involving two or more speakers, only a very narrow subset emerges. Furthermore, within the narrow subset of conversational patterns, one or two patterns typically dominate the entire discussion, occurring exponentially more times than other patterns, with a frequency distribution of patterned recurrence that is fractal. Moreover, resilience in these various social groups has been found to be associated with higher complexity, interpreted as flexibility in the fractal conversational patterns, and perhaps also with looser network ties. For example, the conversational complexity across a six-session family therapy intervention tended to increase over time, session by session, while individual speaker contributions to that complexity became more evenly distributed, suggesting that the relational network among the therapist and family members had loosened up (Pincus et al., 2011). However, network ties were not measured directly in this study; nor was family functioning.

Most consistent across these studies, conflict, and conflict resolution, have emerged as a key process(es) involved in self-organizing roles and response patterns (Pincus, 2001). For example, conflict among therapy group members proved to be the strongest independent predictor of patterning in the fractal structure of the group dynamics over time, above and beyond interpersonal control and closeness (Pincus & Guastello, 2005). Extending these results, Pincus (2014) showed experimental evidence that conflict can drive a small group toward rigidity in their social dynamics, and that conflict resolution is associated with bouncing back to more flexible exchanges.

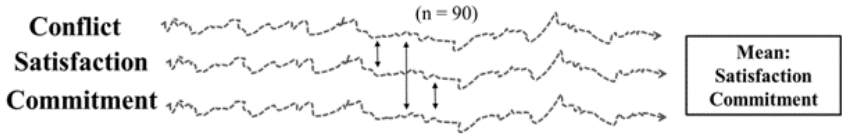

Fig. 1. An illustration of the analytic plan, with conflict, satisfaction and commitment assessed over thirty days, producing a time-series of 90 data points for each participant. Vertical double arrows represent the sequential correlations to be gathered among the three relationship parameters, and the outcome variables (on the right) are means for satisfaction over the 30 days.

The aims of the current study are consistent with several other independent lines of empirical, theoretical, and practical work by researchers interested in conflict dynamics using nonlinear models such as attractors, complex

network simulations, and dynamical equations (Coleman et al., 2007; Gottman, et al., 2002; Vallacher et al., 2010). Each of these lines of research have produced results consistent with the hypotheses here focused on self-organization and fractal dynamics in conflict with these other modeling approaches. As such, it is somewhat surprising that nobody has examined fractal dynamics in general, whether conflict itself, over time, exhibits a fractal structure, what sorts of network dynamics may underlie the emergence of unhealthy conflict dynamics and a loss of interpersonal resilience.

The Current Study

To examine these questions empirically, undergraduate students in committed romantic relationships were recruited and asked to rate their levels of conflict, satisfaction, and commitment on a 5-point Likert scale three times per day for 30 days (n = 90 data points per person; see Fig. 1). There are four stacked hypotheses, each depending on support of the prior. First, levels of conflict over time will generally conform to IPL distributions across the participants. Logically, and consistent with prior research (e.g., Pincus, 2014; Pincus et al., 2019), an average R^2 of .70 or higher will be used as a criterion for this hypothesis. This .70 threshold aims to balance rigor with practicality. If the mean fit to an IPL is less than .70, it would be challenging to argue that the IPL is a good enough model to describe romantic conflict dynamics. By contrast, if the threshold was set higher, one could argue that a valid empirical phenomenon is being discarded due to an arbitrarily stringent threshold, particularly in the context of noisy self-report data.

Hypothesis 2: IPL fit (measured as R^2) or shape (measured as the raw regression weight of the linearized IPL curve, b) will predict mean satisfaction and commitment. It is important to note that this shape parameter, b, is an estimate of fractal dimension. These IPL indices were derived through regression of a linearized version (the log-log plot) of the exponential relationship between conflict size and frequency (Eqs. 1 and 2):

$$Y = aX^{-b} \tag{1}$$

where X is the conflict rating (from 1 to 5), Y is the observed frequency for each rating,
a is a scaling parameter, and b is a nonlinear regression weight representing the shape of the IPL curve. Equation 1 converts to

$$\ln(Y) = \ln(a) - b \ln(X) \tag{2}$$

where b is a linear regression weight and $\ln(a)$ is the intercept.

There are no prior analyses of IPL structure of interpersonal conflict over time, and so unknown to what extent participants will vary in their IPL fits. If there is sufficient variance, then the prediction that better IPL fit is associated with higher mean satisfaction and commitment will be tested. If there is insufficient variance (e.g., if IPL fits across the sample are invariably high), then shape can

be examined for an association with mean satisfaction and commitment. Again, there is no specific prior empirical guidance to inform a specific prediction as to whether a steeper shape, shallower shape, or moderate shape (i.e., mid-level or *optimum variability*, Guastello, 2015) would be associated with more satisfying and committed relationships. Theory would likely predict moderate shape, but not with great confidence as different relationships may leverage different strategies for romantic resilience, such as robustness through the minimization of conflict escalation (i.e., steep shape), or resilience through the cultivation of a high tolerance for conflict (i.e., a shallower shape); see Gottman et al. (2002) for the various stable conflict styles among married couples. Despite the lack of any specific hypothesis about the magnitudes of *b*, self-organizing systems typically produce outputs with fractal dimensions between 1 and 2 (Bak, 1996), and so it will be worthwhile for theory-building and for future empirical analyses in this area to take notice of the values that are observed in the current study.

Hypothesis 3: Moderate correlations among conflict, satisfaction, and commitment across the 90 time-points predict IPL fit (or optimal *b*, depending on the results from hypothesis 1). It is important to make clear that the term "network" as used in this context does not equivalent to "social network" as is usually used to describe a set of individuals with various interpersonal connections. Instead, this study is targeting the romantic relationship itself, not the individuals in the relationship, and is using the term network in a more generic sense. The generic model applied here is meant to describe a system with three or more interconnected nodes, which in this case are conflict, satisfaction, and commitment.

The existing theory of network dynamics, resilience, and self-organization is consistent enough to inform this set of predictions (e.g., Pincus & Metten, 2010; Kiefer & Pincus, 2023). Moderate temporal correlations among these three relationship parameters are expected to provide greater resilience because they are not rigidly over-reactive (i.e., high correlations) or over-stretched, falling apart, and disintegrating (i.e., low correlations). The expectation that loose ties among the relationship parameters will predict IPL fit is designed as a further test the resilience-function of self-organization theory within interpersonal systems. For example, if the IPL fit in conflict dynamics also predicts moderate network ties (in addition to higher satisfaction and commitment), then one may conclude that there is some evidence for a self-regulating mechanism underlying the display of IPL in conflict dynamics over time.

Finally, it is predicted that IPL fit (or shape, *b*) will moderate the correlations between mean conflict and mean satisfaction and mean commitment. This is the most stringent, and most direct test of IPL fit as a resilience-producing factor underlying romantic resilience. If supported, this moderating function would suggest that IPL distributed conflict dynamics function as a buffer against conflict, providing robustness against its negative impacts, allowing couples to maintain relatively high satisfaction and commitment even when mean levels of conflict across the thirty days are higher.

METHODS

Participants

Participants were volunteers from the human subject pool managed by the Department of Psychology in a medium-sized private university. Participation to completion provided three hours of research participation credit for Psychology 101, and for extra-credit in other Psychology courses determined by each individual instructor. The only requirement for participation was to self-identify as being in a committed (i.e., exclusive) romantic relationship. Other than sex, demographic information was not assessed (e.g., race, ethnicity, gender, or sexual orientation), consistent with the goals of a convenience sample, adequate for a theoretical pilot test.

Procedures

Data was obtained from each individual participant and did not include their romantic partners for practical reasons, because of a lack of incentive to allow for partner recruitment and follow-through in the experience sampling. After obtaining informed consent, participants were asked to record the number of months since they had openly committed fidelity to their partners, and then they filled out a seven-item global scale of relationship satisfaction (Hendrick, 1988; importantly, this measure was dropped from the protocol part-way through the sample selection after preliminary analyses showed ceiling effects and insufficient pre-post change across the 30 days to allow for useful analyses). Participants were given standardized instructions about the importance of consistent participation throughout the full 30-day period of assessment, each participant was set up to receive the three item, 5-point (5 = "extreme;" 4 = "a lot;" 3 = "medium;" 2 = "a little;" 1 = "none"), assessment of conflict, satisfaction, and commitment. Participants were informed that they would be excluded from participation, without course credit, if they missed more than three ratings in a row (i.e., one day) or more than 10% of the total ratings (ten or more out of 90). Collectors were sent manually using the Survey Monkey platform during the first phase of data collection (2016-2017), as well as reminders as needed for each participant via email. During the second phase of data collection (2018-2019) survey links were scheduled for automatic distribution using the Qualtrics data platform in the morning (e.g., 9:00 AM), midday (e.g., 2:00 PM) and evening (e.g., 7:00 PM), along with automated reminders for non-responders at 2-hour intervals to improve compliance.

Participants were instructed that the exact time of assessment was not important because schedules vary, but rather to try to spread out their assessments by at least a few hours to ensure that they are making ratings around the start, middle and end of each day. Participants were further instructed that it was okay if they occasionally made late assessments (e.g., filling out the previous evening the next morning upon waking) due to the realities of everyday life. Participants were further instructed that they could send any missing ratings directly to the principal investigator (PI) by email if they had any trouble with survey links, or

that they could record their ratings in some other way (e.g., on paper) if needed in situations where they would be unable to access email for an extended amount of time (e.g., camping trips).

Data Analysis

The general strategy for statistical analyses was simplicity, consistent with the novel hypotheses and design to be carried out, and to facilitate ease of interpretation and replication of any interesting results. Data were analyzed using IBM SPSS statistics (starting with version 24), with original collection occurring across a three-year span from 2016 to 2019 to obtain a large enough sample for statistical power. For hypotheses 1 and 2, regression analyses using the linearized, natural log plot of conflict size (1-5 ratings) and frequencies (standard within SPSS using the "power" curve fitting procedure, see Eq. 2) were used to calculate fit (R^2) and shape (b), which is the raw score of the regression weight. Pearson bi-variate correlation coefficients (with $p < .05$) were used to test the association between these indices of self-organization and mean satisfaction and commitment for each participant across their 30-day experience sample (90 ratings).

Pearson bivariate correlation coefficients were calculated for sequential correlations (without any lags), across each participant's 30-day (90 ratings) experience sample to assess network linkage among the three relationship parameters: conflict, satisfaction, and commitment, for each participant. Mean substitutions were used to supplant any missing data-points, using the mean of the rating just before and after the missing ratings. Quadratic regression analyses were used to test whether moderate linkage among these parameters predicts self-organization, satisfaction and commitment across the 30 days, per hypothesis 3. A significant quadratic model fit together with significant negative beta weights for high and low network linkages, would provide evidence for a "Goldilocks" effect operating within the network dynamics of these dating relationships, with linkages that are too tight (i.e., over-reactive) or too loose (under-reactive) being dysfunctional, and moderate linkages being "just right" in terms of romantic functioning. When applied to predicting IPL fit (or shape), mean satisfaction, and mean commitment across each participant's 30-day experience, this "Goldilocks" effect would provide evidence of a soft assembly network mechanism underlying romantic resilience.

Hypothesis 4, predicting that IPL fit (or shape) would moderate the effects of conflict on satisfaction and commitment, was tested using two multiple-regression analyses with simultaneous entry of three predictors: conflict, IPL index, and their interaction. The IPL index could be fit or shape, depending on the results from hypothesis 1 (see Eq. 3). A significant interaction effect would suggest a moderating influence, suggesting that IPL structure may provide a buffering for the effects of higher conflict on relationship quality (i.e., satisfaction or commitment).

$$r = a + b(x) + b(y) + b(xy) + e \quad (3)$$

where r is the mean relationship quality over the 30 days (satisfaction or commitment), x is the mean conflict over the 30 days, y is the IPL index (either fit or shape), xy is an interaction term, the product of multiplying the IPL index by mean conflict, and e is an error term.

RESULTS

Data Preparation and Exclusions

Over the three-year period, 84 individuals were recruited, six males, and 78 females. Notably, only three participants were dropped for missing data. There were, however, frequent technical glitches and personal follow-ups to participants by the PI to request missing data entries, particularly during the first phase of the study (2016-2017) while using the Survey Monkey platform. During the second phase, late-entry and missing data information was available through the Qualtrics platform and revealed that 1.5% of ratings were late-entries (e.g., altogether at the end of the day, or filling in values in the AM for a prior day), with 24 of these entries carried out manually by the PI after participants had sent their ratings directly to him via secure email. Only 0.6% of data remained missing (n = 16) in the final (N = 51) data set and were filled in using mean substitutions based on the prior and subsequent rating (erring toward the prior rating in cases of fractions). Two participants had six missing data points (i.e., two days) at the end of the study, and it was decided that they would be included without trying to substitute these data (and so their n = 84). About half the participants had n slightly higher than the target of 90 (max = 93) because the PI or one of the research assistants missed their precise end date. It was decided that their data would not be truncated to n = 90 as a slight amount of variance in n across participants is preferable to throwing out a bit of extra data.

Post-hoc, an unworkable lack of variance was discovered for 27 of the 84 participants, requiring exclusion from analysis. Low variance exclusion criteria were determined post-hoc because low variance was not anticipated during the design of the study. The low variance exclusion criteria were set as liberal as possible, to allow for the largest number of participants to be included. As such, the minimum range of conflict values was set at *three*, because three is the minimum to test the fit of an IPL distribution (i.e., two data points can only be plotted in a straight line). For satisfaction and commitment, the minimum was set to *two* distinct values (from 1 to 5), with a minimum of 10% (6 or more) of data points in the lower frequency rating, because correlation and regression analyses aren't possible without variance. For example, one participant had endorsed a rating of five ("extreme") for all but one data point for both satisfaction and commitment, which is equivalent to no variance for statistical purposes. Of the excluded participants, 22 had entered the same value for at least one of the variables across the entire 30-day period, usually at level five ("extreme") for satisfaction and commitment and level one ("none") for conflict.

Three participants were removed because they had a break-up during the thirty-day period (at 29, 39 and 60 data points; each was provided with full

participation credit and an expression of sympathy). The final sample included in the analysis was 51, with 33 exclusions – three due to missing data, 27 for low or no variance, and three for break up.

Descriptive Statistics

Descriptive statistics for primary study variables can be found in Table 1. Several results are noteworthy. Generally, these college dating relationships were described as very low in conflict (conflict mean = 1.61), highly satisfying (satisfaction mean = 4.11) and highly committed (commitment mean = 4.19). In terms of the distributions for IPL related indices, and general evidence for self-organization, the mean fit of conflict values to an IPL was high enough to support hypothesis 1 (mean R^2 = 0.74); yet there was a full range of scores from 0 to 1, and so IPL fit was used for all subsequent analyses, not shape (*b*).

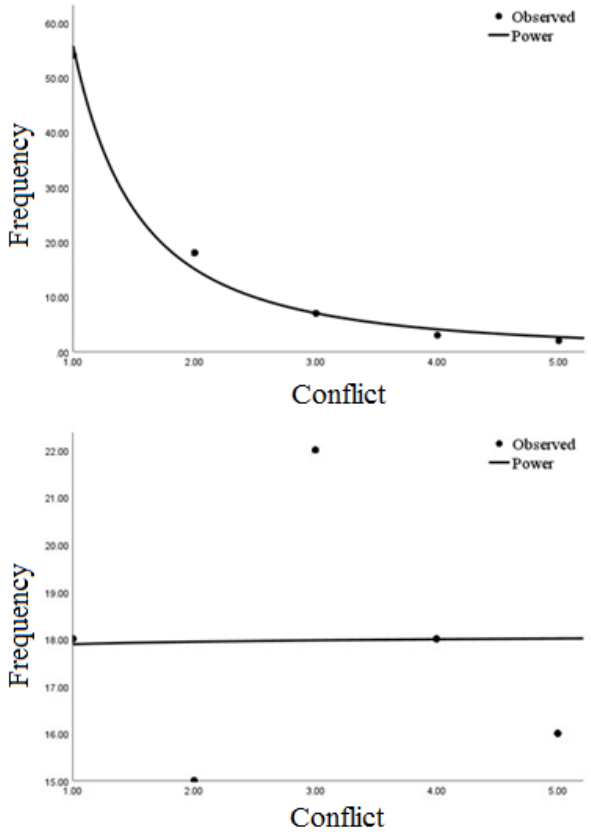

Fig. 2. Inverse power law (IPL) curves for a high fit individual (top; R^2 = .98) and low fit individual (bottom; R^2 = .00).

Satisfaction and commitment had lower degrees of fit (likely due in part to the inclusion of participants with only two distinct ratings for these parameters) but also ranged from 0 to 1, and the mean *b* value (e.g., shape, fractal dimension, *rigidity*) for each parameter was in the expected region for self-organizing systems, between 1 and 2 (Guastello, 2011). Finally, the correlations among conflict, satisfaction and commitment were moderate on average, with sufficient variance to allow for correlational analyses.

Table 1. Descriptive Statistics for Primary Study Variables.

Variable	*N*	*Minimum*	*Maximum*	*Mean*	*SD*
Conflict IPL fit (R^2)	51	.00	1.00	.74	.34
Satisfaction IPL fit (R^2)	51	.00	1.00	.50	.44
Commitment IPL fit (R^2)	51	.00	1.00	.54	.42
Conflict shape (*b*)	51	.00	3.57	1.65	1.03
Satisfaction shape (*b*)	51	.00	6.48	1.38	1.53
Commitment shape (*b*)	51	.00	6.48	1.56	1.72
Conflict mean (*M*)	51	1.11	3.07	1.61	.46
Satisfaction mean (*M*)	51	2.47	4.99	4.11	.69
Commitment mean (*M*)	51	2.25	4.99	4.19	.72
Conflict SD	51	.31	1.39	.73	.24
Satisfaction SD	51	.11	1.39	.67	.27
Commitment SD	51	.11	1.40	.62	.27
Conflict-satisfaction *r*	51	-.89	.22	-.51	.26
Conflict-commitment *r*	51	-.89	.19	-.49	.25
Satisfaction-commitment *r*	51	-.20	.98	.62	.26
Length of relationship (months)	51	2.00	64.00	15.96	12.12

Hypotheses 2 and 3

Table 2 contains the correlations between the primary variable of interest, conflict IPL fit, R^2 and the shape, *b*, of the conflict distributions for each participant, conflict mean, satisfaction mean, and commitment mean. Supporting hypothesis 2, higher conflict IPL fit was significantly associated with higher mean satisfaction across the 30 days ($r = .55$, $p < .01$), higher commitment ($r = .54$, $p < .01$), and lower conflict ($r = -.86.$, $p < .01$). Noteworthy, the large correlation between conflict IPL fit and mean conflict across the 30 days sets up a potential analytic challenge for hypothesis 4 due to multicollinearity between these variables, and a potential confound for interpreting the correlations between IPL

fit and both satisfaction and commitment. Conflict IPL fit and conflict shape, *b*, were highly correlated as well ($r = .81$, $p < .01$). Together, these results suggest that low IPL fitting conflict patterns were generally due to flatter distributions, with larger tails that reflect higher levels of conflict.

Table 2. Correlations among Variables for Testing Hypothesis 2.

Variable	*Conflict IPL R^2*	*Conflict b*	*Conflict M*	*Commitment M*
Conflict IPL R^2	--			
Conflict *b*	.81**	--		
Conflict *M*	-.86**	-.81**	--	
Satisfaction *M*	.55**	.50**	-.66**	--
Commitment *M*	.54**	.46**	-.70**	.74**

N = 51 for all variables. **$p < .01$ (two tailed).

Hypothesis 3 was tested using quadratic regressions, with IPL fit as the criterion and the Pearson correlation coefficients among conflict, satisfaction, and commitment as predictors. The plots of these results can be found in Fig. 3. There were significant quadratic effects for each of the conflict linkages, conflict-satisfaction $R^2_{adj} = .29$; $F(2, 50) = 11.19$; $p < .01$ and conflict-commitment $R^2_{adj} = .15$; $F(2, 50) = 5.42$; $p < .01$), but not for the satisfaction-commitment linkage $R^2_{adj} = .03$; $F(2, 50) = 0.63$; $p = .54$ For each of the significant quadratic effects, both sides of the parabola made equivalent contributions to the overall fit ($\beta = -1.5$, $p < .01$ for each side of the conflict-satisfaction parabola; and $\beta = -1.22$, $p < .01$, and $\beta = -1.27$, $p < .01$ for left and right sides of the conflict-commitment parabola respectively).

Hypothesis 4

Hypothesis four tested whether conflict IPL fit would moderate the relationships between conflict and satisfaction and conflict and commitment. Multicollinearity appears likely to present a challenge to testing this hypothesis, due to the strong correlation between IPL fit and conflict ($r = -.86$). The predictor variables were centered by subtracting the mean from raw scores with the goal of hedging against this problem a bit. Normality and scedasticity each appeared to be within acceptable limits through visual inspection of a normal P-P plot of expected versus observed cumulative probability and the scatterplot of residuals for both satisfaction and commitment. The only variance inflation factor (VIF) greater than 5 was conflict (VIF = 5.02), with the tolerance index equaling .20 (i.e., 80% shared variance) suggesting that collinearity was indeed significant enough to cause problems in the analysis as suggested by the bivariate correlations, but not so high (e.g., greater than 10) to render the analysis useless.

The results of the multiple regression analyses with simultaneous entry of the three centered predictors (conflict, IPL fit, and their interaction term) did not support hypothesis four, with conflict emerging as the sole predictor of satisfaction ($\beta = -.72$; $p < .01$; $R^2_{adj} = .40$; $F = 11.96$; $p < .01$) and also commitment

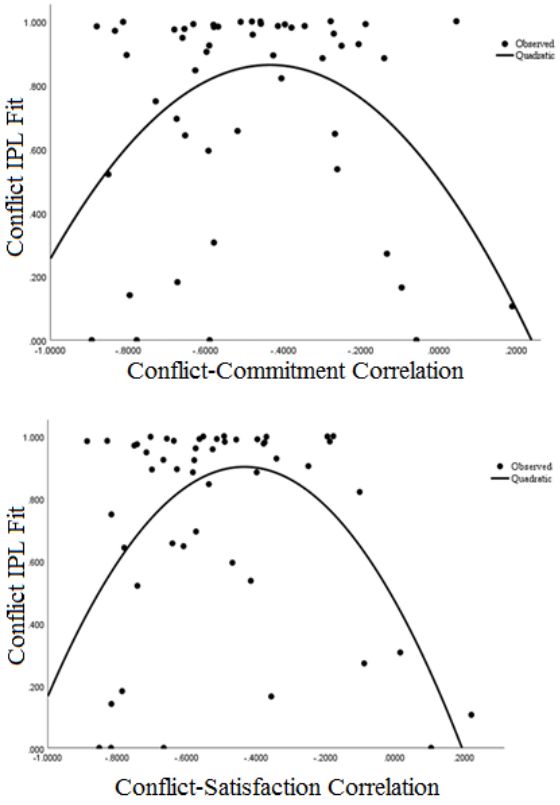

Fig. 3. Quadratic regression plots for IPL Fit (R^2) on bivariate Pearson correlations between each pair of relationship parameters: conflict and satisfaction (top; R^2_{adj} = .29, p < .001), and conflict and commitment (bottom; R^2_{adj} = .15, p = .008). There was no relationship found between IPL fit and satisfaction-commitment linkage.

(β = -.76; p < .01; R^2_{adj} = .48; F = 16.22; p < .01), with IPL fit and the interaction term each dropping out of the models as non-significant predictors. Because of the multicollinearity observed with the conflict variable, the support for hypotheses 1 to 3, and the first-time, pilot nature of the present study, a post-hoc analysis was performed using only IPL fit and the fit by conflict interaction term to predict mean satisfaction and commitment across the 30 days.

With conflict removed, the interaction term was a significant predictor of commitment (β = .45; p < .01; R^2_{adj} = .37; F = 15.69; p< .01), knocking out the effects of IPL fit as a predictor (β= .22; p< .16). The opposite was the case in predicting satisfaction; the interaction term was no longer significant in the model (β = .23; p = .18), but IPL fit remained (β = .39; p < .05; R^2_{adj} = .30; F = 11.76; p < .01).

Table 3. Regression Results for Moderation Analysis.

Independent variable	β	*t*	*p*
DV = Mean Satisfaction. R = .658			
Conflict IPL Fit	-0.041	-0.193	.847
Conflict Mean	-0.723	-2.936*	.005
IPL Fit X Conflict Mean	-0.039	-0.219	.827
DV = Mean Commitment. R = .713			
Conflict IPL Fit	-0.228	-1.150	.256
Conflict Mean	-0.755	-3.294*	.002
IPL Fix X Conflict Mean	0.174	1.048	.300

*$p<.05$. DV = dependent variable.

Post-hoc Analyses

Again, the lack of support for hypothesis four was not supported based on the insignificant interaction effect for IPL fit and conflict in predicting satisfaction or commitment. However, the results are inconsistent with the support for hypotheses 2 and 3, and there appear to be a few methodological constraints that could have contributed to the null result. Based on these factors, it is prudent to gather some additional, post-hoc, information to guide future research.

Removing conflict, which had the highest level of multicollinearity with IPL fit and the interaction term, resulted in mixed results, with the interaction term knocking out IPL fit to predict mean commitment, and the opposite result (IPL fit remaining, with the interaction term dropping out) when predicting mean satisfaction. This suggests that IPL fit may have a buffering effect against conflict that could not be observed on this sample, particularly in buffering the impacts of conflict on commitment. Another post-hoc analysis compared high versus low IPL fit participants based on a median split (at R^2 = .90), and several potential differences became apparent. Most notably, the regression coefficients between conflict and satisfaction were about three times larger for the low IPL fit participants (R^2 = .41, p < .01; and R^2 = .13, p = .08 respectively; see Fig. 4). The relationship between conflict and commitment were even more striking, with conflict and commitment sharing 70% of their variance in the high fit participants and only 8% in the low fit sample (R^2 = .70, p < .01; and R^2 = .09, p = .16 respectively). Conflict clearly has a stronger relationship with satisfaction and with commitment when IPL fit is low, and the crossed regression lines, if observed without the more important moderation model itself, would suggest a significant interaction effect for commitment (see Fig. 4).

The high fit individuals had significantly lower levels of conflict as well (M = 1.9 vs. 1.3 respectively, t = 5.80, p < .01). Altogether, one could argue that each of these bits of evidence suggest that high IPL fit is indeed protective against the negative impacts of conflict on commitment as predicted by hypothesis 4.

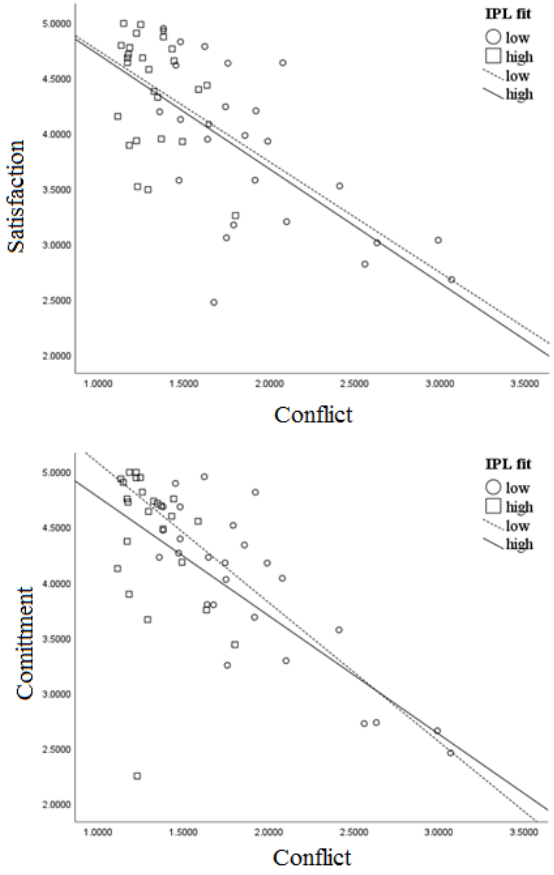

Fig. 4. Scatterplots between conflict mean and satisfaction mean (top) and commitment mean (bottom) with regression lines displayed for high IPL fit individuals and low IPL fit individuals.

Again, however, the moderation models which include mean conflict, IPL fit, and their interaction are the most important empirical indicator, and they do not support this conclusion. A better conclusion to account for these apparently mixed results is that the current results are simply inconclusive one way or the other, warranting further empirical study. In addition to the high multicollinearity between mean conflict and IPL fit, the invariably low levels of conflict in the high IPL fit group likely capped the ability to meaningfully test the buffering hypothesis in the moderation models. Extending this line of reasoning, the variance in conflict across individuals was about three times higher in the low IPL fit group compared to the high IPL fit group (high fit *SD* = 0.17 vs. low fit *SD* =

0.48). While *within* the individuals' reports of conflict over the 30 days there was also significantly less variance in conflict ($t = 3.29$; $p < .01$). It appears that each potential empirical indicator supports the conclusion that resilience is conveyed through self-organization (i.e., high IPL fit), except for the moderation model (the most important test), and that each supportive indicator also serves to increase the headwind against the necessary statistical power to adequately test the moderation model.

DISCUSSION

The aims of the current investigation were to examine whether interpersonal conflict dynamics in romantic relationships are fractal, suggesting that they are self-organizing, and if so, how and to what extent may self-organization promote adaptive resilience. Four stacked hypotheses were tested. First, the conflict dynamics observed in the current study appear to be generally fractal. The mean fit to an IPL distribution across the sample of participants was $R^2 = .74$, and the mode was even higher at $R^2 = .90$, supporting hypothesis 1. Second, better IPL fit was significantly correlated with mean satisfaction ($r = .55$, $p < .01$) and mean commitment ($r = .54$, $p < .01$) across the 30 days, supporting hypothesis 2. This evidence suggests that self-organizing conflict dynamics provide robustness in relationship satisfaction and commitment, each of which is necessary to maintain the existence of the relationship over time.

Hypothesis 3 goes a bit further, suggesting that an underlying mechanistic factor driving the emergence of self-organizing, IPL distributed, conflict is flexible network connectivity (aka *loose ties* or *soft assembly;* see Kiefer & Pincus, 2023; Pincus & Metten, 2010); among conflict, satisfaction, and commitment over time. This hypothesis was partially supported, with moderate temporal correlations across the 30 days between conflict-satisfaction and conflict-commitment linkages predicting better IPL fits, but not for satisfaction-commitment linkages.

One interpretation for this finding is that conflict serves a unique regulatory function, different in kind to parameters like satisfaction or commitment, which would be consistent with prior research (Coleman et al., 2007; Gottman et al., 2002; Pincus & Guastello, 2005; Vallacher et al., 2010) and also most applied theories of interpersonal functioning. Specifically, each of these lines of inquiry suggests that conflict emerges within a context of short-term constraint that leads to transformation, development, and growth. Analogously, fractal branching structures in various living systems (e.g., trees, neural networks, cardiovascular systems) are efficient and adaptive as they provide resilience as they grow, with the fractal branching structures combining structural integrity (e.g., a few large branches) with flexibility (e.g., many small branches). The current results are consistent with this idea that healthy conflict serves the purpose of relational growth through structural resilience, with large-scale conflict resolutions serving to increase the integrity of the romantic relationship by opening a few large relational spaces, and many small-scale conflicts creating flexibility (Pincus, 2001, 2015; Pincus & Guastello, 2005). Ongoing replication

and extension of these results will be needed to examine this interpretation more directly and specifically. Nevertheless, the current results provide evidence that flexible network reactivity between conflict and satisfaction and commitment is associated with fractal conflict dynamics, and that this fractal structure is associated with higher satisfaction and commitment over time.

Finally, the most challenging test of the resilience-conveying function of IPL structure in romantic couples was not supported, with a failure to discern a significant moderating effect of better-fitting IPL structure buffering the impacts of conflict on satisfaction and commitment across couples. There were, however, several methodological constraints that may have interfered with the ability to adequately test this hypothesis, which may suggest that the results are inconclusive and should be tested again using a better design. The most significant impediment was the high multi-collinearity between conflict and conflict IPL fit when predicting satisfaction and commitment. Additionally, there was little variance in this sample of college daters in any of the parameters, either across time for individuals or between individuals across the sample. Furthermore, some post-hoc analyses suggested that with more independent parameters than conflict and conflict IPL, with different outcome criteria, or with a different sample of romantic partners, this buffering effect may be detectable. For example, the regression coefficients between conflict and satisfaction and conflict and commitment were around three and seven times smaller for the high IPL fit participants than for the low IPL fit participants (see Fig. 4). Still, the results for hypothesis four should be considered inconclusive at best at the present time.

Limitations

First, this sample of college daters may be unique in several important respects compared to other romantic couples, limiting the generalizability of these results. Most notably, they would not have been together as long as most married (or other more mature) couples. One post-hoc strategy using the current data might have been to analyze a subset of the current sample who had been in relationships longer-term, perhaps with a greater resemblance to mature relationships and so less hampered by low conflict and conflict variance. Length of relationship in months displayed a good range, from two months to 64 months with an average of just under 16. However, the length of the relationship in months was not correlated with any of the other primary variables of interest, and so there is no evidence within this data set to suggest that longer-term romantic partnerships have distinct levels of conflict, satisfaction, or commitment; nor that they vary in their IPL dynamics over time. Altogether, a conservative, yet pragmatic interpretation of the combined results would be to conclude that they do suggest a *potential* role for self-organization in providing resilience in romantic relationships (consistent with the results from hypotheses 1 to 3), but that testing these more empirically rigorous resilience effects would require a broader and more generalizable sample of romantic couples, such as married couples. In addition, the design of the study included only one partner due to availability

within a subject pool recruiting context, and all but three participants in the analyzable sample were female.

Beyond obtaining a more generalizable and potentially and more varied sample with respect to conflict levels, and the inconclusive (at best) results with respect to hypothesis 4, several other methodological limitations should be addressed in future research examining the role of conflict in romantic resilience. Perhaps most importantly, there were 33 exclusions out of 84 total participants, with 27 excluded for a lack of variance in one or more parameters across the 30 days. There is no way to know for sure if those folks were slacking or if they were making valid reports and their relationship parameters simply were not changing over time. If valid, these individuals would appear to have extraordinarily positive, stable, potentially uninteresting, and superficial relationships. It may seem more plausible that there were high levels of loafing at play, especially because this was a 30-day, three times per day experience sampling study with undergraduates motivated primarily to receive course credit.

The two explanations, loafing and superficiality, are not mutually exclusive though. Even for the included participants, the mean conflict levels were very low, and satisfaction and commitment were very high. One may reasonably wonder whether this is related to the specific context of college dating, which may be unique in some respects compared to other dating relationships where the prospect of marriage is more prescient. Perhaps college dating relationships are more stable because they are more fragile, and so tend to be conflict avoidant and biased towards exaggerated perceptions of satisfaction and commitment? Perhaps there is less pressure as most college couples do not live together, have a variety of individual activities, and a wide range of social outlets to engage beyond their partners? There is no way to conclusively determine the reason for the lack of variance in 27 of the 84 college daters without extension of the current methods to other types of romantic relationships, such as married couples.

There are many methodological limitations worth noting beyond the constrained sample and high exclusion rates. The ratings in each of the parameters over the 30 days are likely to have significant errors (e.g., late entries, careless entries), along with a lack of nuance and variance given their one to five Likert formatting. This would most likely create a bias against supporting the hypotheses proposed here, not in favor of them. However, a wider range of values, with a slider option for data entry may be preferable in future studies.

Similarly, the IPL fitting procedure employed may be characterized as crude, and certainly is a very basic option. As an initial pilot test, the strategy employed was to keep all analyses as simple as possible, and again would not be expected to create a favorable bias. However, one should be very cautious in trying to draw any firm conclusions that these data are IPL distributed specifically as opposed to any of the other fat-tailed exponential distributions. However, for the purposes of the current research context, and for many self-reported psychological phenomenon, mathematical purity must necessarily be of lower priority than practicality. This is why the validity of any measure is so important in any psychological context, and why the hypotheses beyond hypothesis one in

the current study (i.e., finding a high enough mean IPL fit) are of critical importance. Nevertheless, future studies may wish to include a wider variety of entropy measures, particularly time-based sequential indices and indices derived from change scores rather than simple ratings.

One may criticize the current study further on the grounds that there is at least a small degree of criterion contamination at play. Most notably, the high correlation between IPL fit and mean conflict levels is not spurious. The two indices are indeed confounded with one another, since higher mean levels of conflict will necessarily reduce the size of the mode of an IPL distribution and fatten up its tail. This confound might not be so large as to be unworkable, but it cannot be fully removed or accounted for either. This should be a consideration in the planning of any future replication or extension of the current results.

Similarly, the three parameters selected for the current study (conflict, satisfaction, and commitment) were each highly intercorrelated across individuals, and with IPL fit to a lesser extent. This creates a potential criticism regarding the construct validity of each parameter: To what extent are each of these distinct constructs? The original analytic plan called for the use of a more global, multiple item pre- and post-satisfaction scale, and to use change across the 30 days as the criterion, rather than mean ratings across the 30 days. However, when examined part way through the three-year data collection period, large ceiling effects, and lack of change in this global measure were found, and so that plan was discontinued. Other post-hoc analyses were considered, including using standard deviation in satisfaction and commitment rather than mean values, and an attempt to operationalize an idiographic *return to attractor* index, each of which might represent something closer to resilience (i.e., bouncing back from negative impacts) and not only robustness (i.e., withstanding conflict without negative impacts). Ultimately, mean values across the 30 days were selected as the sole criteria due to the pilot nature of the current study and for simplicity of analysis and reporting (however, data can be made available on a case-by-case basis for curious researchers interested in testing other hypotheses).

Theory and Applications

Despite the many limitations and the lack of support for hypothesis 4, the current results make a potentially important incremental theoretical and practical contribution to understanding the role of self-organization in providing resilience within interpersonal dynamics. The finding that interpersonal conflict dynamics over time can be modeled as fractals (as IPL or other fat-tail distributed phenomena) and that this fractal structure is associated with better relationships (i.e., hypotheses 1 and 2) is a key finding by itself. This result adds to prior empirical evidence suggesting that other self-organizing biopsychosocial dynamics display resilience-making fractal dynamics as well (Kiefer & Pincus, 2023).

Beyond this relatively simple result, the current study lends more direct support for the role of self-organization in providing self-regulation in human relationships, a key function underlying resilience within systems. Specifically,

the current results add to the understanding of IPL structure as an index of self-organizing resilience through the addition of a simple network analysis among conflict, satisfaction, and commitment over time. These results (i.e., hypothesis 3) suggest that the IPL structure in conflict dynamics emerges through the *soft assembly* (aka loose ties) in the underlying network upon which the relationship rests, conveying moderate reactivity between conflict and both satisfaction and commitment. This connection between soft assembly and emergent IPL conflict dynamics adds to prior evidence suggesting that closeness, conflict, and control may act as structure-making parameters that lead to the emergence of IPL dynamics in small groups (Pincus & Guastello, 2005), and experimental evidence suggesting that conflict and conflict resolution can trigger shifts in dynamical complexity within an IPL distributed, self-organizing interpersonal process (Pincus, 2015).

On a broader and more methodological level, this potential empirical connection between IPL dynamics, loose network ties, and human resilience lends some support to the strategy of combining multiple models when feasible within the same study to better understand self-organizing biopsychosocial resilience: *many models, one theory* (Kiefer & Pincus, 2023; Pincus & Metten, 2010). The current results may help to correct the general tendency for network approaches to psychopathology and resilience to focus exclusively on tight network ties as a source of resilience loss, rather than testing for soft assembly, flexible linkage, instead (cf., Cramer & Borsboom, 2015). The present results suggest, in at least this one relational context examined here, that network *disintegration* may also be an important factor in resilience loss (see Fig. 2).

In the case of romantic couples, concerns about disconnection would involve strategies aimed at re-engagement through conflict, such that conflict may involve each partner having more investment, more to lose, and perhaps more to gain on the other side of a conflict resolution. Some flexible risk to one's satisfaction and commitment may be an essential part of the bargain if one is to deepen mutual satisfaction and commitment over the span of the relationship. This would help to de-pathologize situations where it appears that one partner is baiting the other, pulling for a conflict, apparently motivated by a desire for deeper connection, even if it is uncomfortable. This situation may describe distressed couples stuck within cycles of criticism/contempt from one partner and defensiveness/stonewalling from the other (Gottman et al., 2002). Other couples may be mutually disconnected from one another, and so lacking in conflict overall and particularly the small-scale high frequency conflicts that may serve to balance the larger ones. These disconnected couples may be the ones that break up cold, due to distance, rather than hot, due to volatility.

If this "reconnection" strategy is extended to psychopathology, it may serve to better-inform situations such as the numbness that often signals depression, rather than sadness per se, and the clinical phenomenon whereby some clients need to re-engage with their feelings in order to re-connect to their awareness of their own needs, even if it is disruptive, uncomfortable, and dysregulating in the shorter-term (cf., de Felice, et al., 2022).

The most general conclusion from the current results may be support for the general strategy found in most approaches to couples therapy, that conflict is neither bad nor good per se. Rather, the functionality of conflict would depend upon the dynamical context, whether the conflict is balanced or unbalanced, regulated, or unregulated (Gottman et al., 2002; Vallacher et al., 2010). Increasing the number of small conflicts may be a key strategy for couples whose balance is thrown off by the presence of too many larger scale conflicts. While couples who get stuck in cycles of conflict avoidance may serve to increase their vulnerability, making short term gains in exchange for longer term vulnerability.

Alternatively, one may aim at *diffusion* strategies, to place more slack in the reactions among conflict, satisfaction, and commitment, for couples who are overreactive to one another. A large variety of strategies already exist for over- and under-reactivity, across various approaches to couples therapy, as well as within individual approaches to therapy aimed at self-relations and internal conflicts (for practical reviews, see Pincus, 2015, 2016, 2024).

As a less practical, and more philosophical take-away, the present results may be seen as another small empirical step toward psychotherapy integration, including the combining of individual and conjoint approaches under the rubrics of complexity theory. More broadly, continued empirical study of the dynamics of conflict may bring theoretical integration well beyond a common understanding for romantic resilience as emergent and self-organizing. We may begin to gain a common understanding of the role of self-organizing conflict and conflict-resolution to promote resilience and growth within individuals over developmental time, within our various intimate relationships, within family and larger groups, and perhaps stretching to the scale of societies, where under-standing conflict resolution and social resilience may have the greatest impact.

REFERENCES

Bak, P. (1996). *How nature works: The science of self-organized criticality.* New York: Springer-Verlag.

Berardi, V., Pincus, D., Walker, D., & Adams, M. A. (2021). Burstiness, and stochasticity in the malleability of physical activity. *Journal of Sport & Exercise Psychology, 43,* 387-398. doi:10.1123/jsep.2020-0340.

Coleman, P. T., Vallacher, R. R., Nowak, A., & Bui-Wrzosinska, L. (2007). Intractable conflict as an attractor: A dynamical systems approach to conflict escalation and intractability. *American Behavioral Scientis*t, *50*, 1454-1475.

Cramer, A. O. J., & Borsboom, D. (2015). Problems attract problems: A network perspective on mental disorders. *Emerging Trends in the Social and Behavioral Sciences: An Interdisciplinary, Searchable, and Linkable Resource.* New York: Wiley. doi:10.1002/9781118900772.etrds0264

de Felice, G., Giuliani, A., Pincus, D., Berardi, V., Aichhorn, W., Schöller, H., & Schiepek, G. (2022). Structure and flexibility in psychotherapy process predict outcome, *Acta Psychologica*, *227*, doi:10.1016/j.actpsy.2022.103604.

Gottman, J., Swanson, C., Swanson, K. (2002). A general systems theory of marriage: nonlinear difference equation modeling of marital interaction. *Personality and Social Psychology Review*, *6*, 326-340.

Guastello, S. J. (2011). Frequency distributions and error functions. In S. J. Guastello & R. A. M. Gregson (Eds.), *Nonlinear dynamical systems analysis for the behavioral sciences using real data* (pp. 33-72). Boca Raton, FL: CRC Press/Taylor and Francis.

Guastello, S. J. (2015). The complexity of the psychological self and the principle of optimum variability. *Nonlinear Dynamics, Psychology, and Life Sciences*, *19*, 511–527.

Guastello, S. J., & Liebovitch, L. (2009). Introduction to nonlinear dynamics and complexity. In S. J. Guastello, M. Koopmans, & D. Pincus, (Eds.), *Chaos and complexity in psychology: The theory of nonlinear dynamical systems.* New York: Cambridge University Press.

Hendrick, S. S. (1988). A generic measure of relationship satisfaction. *Journal of Marriage and Family, 50,* 93-98.

Kauffman, S. A. (1995). *At home in the universe.* New York: Oxford University Press.

Kello, C. T., Anderson, G. G., Holden, J. G., & Van Orden, G. C. (2008). The pervasiveness of 1/f scaling in speech reflects the metastable basis of cognition. *Cognitive Science, 32,* 1217-1231.

Kiefer, A. W., & Pincus, D. (2023). Biopsychosocial resilience from a complex adaptive systems lens: A narrative review of nonlinear modeling approaches. *Nonlinear Dynamics, Psychology and Life Sciences, 27,* 397-417.

Pincus, D. (2001). A framework and methodology for the study of nonlinear, self-organizing family dynamics. *Nonlinear Dynamics, Psychology, and Life Sciences, 5,* 139-174.

Pincus, D. (2014). One bad apple: Experimental effects of psychological conflict on social resilience. *Interface Focus*, *4,* 20014003. doi: 10.1098/rsfs.2014.0003.

Pincus, D. (2015). Experiential balancing therapy: An integrative psychotherapy theory and approach grounded in complex adaptive systems theory. Part I: Theoretical overview and key concepts. *Chaos and Complexity Letters, 8(2-3),* 179-201.

Pincus, D. (2016). Experiential balancing therapy: An integrative psychotherapy theory and approach grounded in complex adaptive systems theory. Part II: Assessment, treatment planning, and intervention. *Chaos and Complexity Letters, 9(2),* 139-166.

Pincus, D. (2024). Integrity, flexibility, and balance: How change works in Psychotherapy. In K. Taku & T. K. Shackelford (Eds.), *The Routledge international handbook of changes in human perceptions and behaviors.* New York, NY: Routledge.

Pincus, D., Cadsky, O, Berardi, V., Asuncion, C.M., & Wann, K. (2019). Fractal self-structure and psychological resilience. *Nonlinear Dynamics, Psychology and Life Sciences, 23,* 57-78.

Pincus, D., Eberle, K., Walder, C. S., Sandman, C. A., Kemp, A. S., & Mabini, C. (2014). The role of self-injury in behavioral flexibility and resilience. *Nonlinear Dynamics, Psychology and Life Sciences, 18,* 277-298.

Pincus, D. & Guastello, S.J. (2005). Nonlinear dynamics and interpersonal correlates of verbal turn-taking patterns in group therapy. *Small Group Research, 36,* 635-677.

Pincus, D., & Metten, A. (2010). Nonlinear dynamics in biopsychosocial resilience. *Nonlinear Dynamics, Psychology, and Life Sciences, 14,* 253-280.

Pincus, D., Ortega, D., & Metten, A. (2011). Orbital decomposition for the comparison of multiple categorical time-series. In S. J. Guastello & R. A. M. Gregson (Eds.),

Nonlinear dynamical systems analysis for the behavioral sciences using real data (pp. 517-539). Boca Raton, FL: CRC Press/Taylor and Francis.

Riris, P., Silva, F., Crema, E., Palmisano, A., Robinson, E., Siegel, P. E. ... Ren, X. (2024). Frequent disturbances enhanced the resilience of past human populations. *Nature*. doi:10.1038/s41586-024-07354-8

Schuldberg, D., & Gottlieb, J. (2002). Dynamics and correlates of microscopic changes in affect. *Nonlinear Dynamics, Psychology, and Life Sciences*, *6*, 231-257. doi: 10.1023/A:1015063927555

Vallacher, R. R., Coleman, P. T., Nowak, A., Bui-Wrzosinska, L. (2010). Rethinking intractable conflict: the perspective of dynamical systems. *American Psychologist*, *65*, 262-278.

Wong, A. E., Vallacher, R. R., & Nowak, A. (2014). Fractal dynamics in self-evaluation reveal self-concept clarity. *Nonlinear Dynamics, Psychology, and Life Sciences*, *18*, 349–369.

Wong, A. E., Vallacher, R. R., & Nowak, A. (2016). Intrinsic dynamics of state self-esteem: The role of self-concept clarity. *Personality and Individual Differences, 100,* 167-172.