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# One bad apple: experimental effects of psychological conflict on social resilience

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Past research suggests that small groups are self-organizing systems, and that social resilience may be measured as the meta-flexibility of group dynamics: the ability to shift back and forth from flexibility to rigidity in response to conflict. This study extends these prior results, examining the impact of experimentally induced internal conflict and group-level conflict resolution on group dynamics—*whether one bad apple can spoil the bunch*. Six experimental groups with four members each participated in a series of four 25 min discussions. The first two discussions served as a baseline condition. Internal conflict was induced to one or more group members prior to discussion three, with the prediction that higher levels of conflict induction would lead to significant drops in group flexibility—creating a press on the group's resilience, whereas conflict resolution in discussion four was expected to allow for a rebound in group flexibility. Consistent with prior research, the turn-taking dynamics of each the 24 groups were distributed as inverse power laws ( $R^2 = 0.86\text{--}0.99$ ) providing evidence for self-organization. Furthermore, there were significant study-wise negative correlation between levels of personality conflict and two measures of flexibility: information entropy ( $r = -0.47$ ,  $p = 0.019$ ) and fractal dimension ( $r = -0.42$ ,  $p = 0.037$ ). Altogether, these results suggest that: (i) small groups are self-organizing systems with structure and flexibility providing social resilience and (ii) individual conflict is able to spread to higher level social dynamics, creating pressure on social resilience. Practical implications for assessment of, and intervention with, psychosocial resilience are discussed.

## 1. Introduction

The nature of conflict as it emerges and flows among individuals and small groups has been a key topic throughout the history of personality, social and clinical psychology [1,2]. At the same time, methods that are capable of capturing the complex, nonlinear and reciprocal interactions between individual- and group-level conflicts have been in short supply. It is clear that conflict is a ubiquitous process in both personality and social dynamics. Furthermore, the manner in which conflict spreads has great practical significance for understanding psychosocial resilience—the ability of individuals and groups to withstand the pressures of conflict, and to 'bounce back' and adapt through conflict resolution.

Nevertheless, conflict has remained illusive to measurement, modelling and deeper integrative theory. Fundamental questions remain, particularly with respect to the dynamical and structural aspects of conflict. For example: 'How does conflict spread within and among personality and social dynamics over time? What is the structural significance of conflict and conflict resolution with regard to personal or social resilience? What is the function of conflict and conflict resolution in personal and social growth and adaptation?' One question that is especially prescient is the impact of individuals on group dynamics. Many lines of research since the 1950s have demonstrated the incredible effects that groups can have on individual behaviour (see [1] for a review). Yet, the impact of a conflicted personality on social dynamics is less clear—*Can one bad apple spoil the bunch?*

This study addresses these questions by examining the spread of conflict from personality up to the level of the small group using methods from nonlinear dynamical systems theory (NDS). NDS represents the current state-of-the-art in general systems theory. It is commonplace within the various branches of the physical and life sciences, and in the past two decades has become more commonplace within the various domains of psychology [3].

Personality and social psychology have a long tradition, beginning with Lewin's *Field Theory* [4] of considering complex interactions of multiple variables over time to understand the emergence of psychosocial patterns. However, social psychological research has too often been saddled by an over-reliance on linear and static methods, which are grounded in classical notions of proportional cause and effect, reductionism and the separation of 'true signal' from 'random error'. The 'model' by default has been straight line relationships among variables which are assumed to be independent of one another, fitting Gaussian (bell-shaped) frequency distributions. By contrast, NDS models allow one to investigate complex, multi-level, systemic and interdependent processes as they unfold over time [5,6]. Such processes may involve complex and multi-directional patterns of cause and effect, deterministic variability (i.e. dependent error) and frequency distributions such as inverse power laws (IPLs) reflecting non-independence among observations and evidence for self-organization.

## 2. Self-organization, flexibility and resilience in group dynamics

The use of NDS in this study is designed to deepen the existing knowledge base with respect to the structural relationship between conflict and rigidity, and to further develop a research paradigm capable of direct measurements of the structural resilience of small groups. Pincus & Metten [7] define resilience within self-organizing biopsychosocial systems in structural terms as the *meta-flexibility* of a system: *the ability to move smoothly between rigidity and flexibility without getting stuck or falling apart*. Using this theoretical lens, the rigidity that accompanies conflict may be seen as a resilience-making process—whereby the social system is accommodating to the pressure of conflict by shifting towards rigidity in order to hold together. If accurate, internal conflict within one or more group members should carry the potential to shift group dynamics towards rigidity. In addition, one would expect group dynamics to demonstrate a resilient 'bounce back' response: shifting back towards flexibility through the process of conflict resolution.

Several studies have found evidence for self-organization in families [8,9] and other small group dynamics [10], along with reliable associations between the flexibility of group dynamics and levels of conflict. Pincus *et al.* [11] extended these correlational results to a single-case experimental paradigm, which serves as the pilot to this study. This study extends this single-case experimental procedure to an aggregated design, with five additional groups with various levels of experimental conflict induction. Across the additional groups, the number of induced members ranges from zero (no members induced with conflict; a control condition group) to all four members induced with conflict. The resulting relationship between degree of conflict induced and the structure of group conversation dynamics may then be analysed.

Six groups of four individuals participated in a series of four 25 min discussions. In the five experimental groups, false feedback was given during the break between the second and third discussions. As a manipulation check, each participant was asked verbally to rate on a Likert scale how accurate the false feedback was—with higher discrepancy ratings indicating higher self-conflict. The result was that levels of conflict during discussion three ranged from zero (no members induced) to a maximum of four (all four members with 100% induction).

Between discussions three and four, induced members were given permission to discuss with other members any disagreements with the false feedback, allowing for the possibility of conflict resolution and the potential for a 'bounce back' towards flexibility in the group dynamics. Using objective criteria, a score was derived reflecting the degree of conflict resolution achieved during discussion four for each group (ranging again from 0 to 100%).

This procedure produces an independent variable ranging from 0 to 4 based on the level of induced conflict present during each of the 24 discussions (six groups  $\times$  four discussions per group), which could then be analysed for a general association with measures of flexibility experiment-wise. Flexibility was operationalized as the complexity in turn-taking patterns (the dependent variable), using two well-known measures from NDS: (i) *fractal dimension* [12,13] and (ii) *information entropy* [14,15].

Hypothesis 1: 'It is predicted that the turn-taking patterns of each discussion will fit an IPL model'. This result would extend prior evidence suggesting that self-organization is a universal process underlying group dynamics and structural resilience.

Hypothesis 2: 'It is expected that the levels of conflict across each of the 24 discussions will show a significant negative association with the complexity of turn-taking dynamics as measured by both information entropy and fractal dimension'. This result would extend prior correlational [10] and single-case experimental results [16] suggesting that the rigidity associated with conflict serves a resilience-making function.

## 3. Material and methods

### 3.1. Participants and task

The participants were 24 females, predominantly European-American ( $N = 20$ ), followed by Asian-American ( $N = 3$ ) and African-American ( $N = 1$ ), between the ages 18 and 19 years. All were undergraduate students at a mid-sized private university who volunteered to participate in this study to complete a required research experience for a psychology course. All participants were strangers, with no common friendships prior to the investigation. Each of four discussion sessions was 25 min in length, was video-recorded and was monitored by investigators through a one-way camera from a separate room. Participants were instructed to take one of four positions on two sofas situated at a right angle surrounding a coffee table and were instructed to remain on their own cushion throughout the discussion to allow for proper video-recording.

The conversations were designed to be simple, open-ended get-to-know one another tasks in order to be as naturalistic as possible. The following are the instructions given to each group about the topics they should discuss:

[Read aloud to group] You are going to participate in four 30-min discussions. Each discussion will be separated by a 10- to 15-min

break in which you will be given some forms to read and fill out. If you need to use the restroom at any point during the study, please do so during one of these breaks. Your task within the discussion will be to get to know one another as well as you can within the time constraints. Some topics you should explore include: (i) your current school life, such as your social life and studies; (ii) your family background, including relationships with parents and siblings; and (iii) your future plans and goals. Other areas might be important as well, such as your personal values, political beliefs, and so on. But please be sure to cover the three areas listed at a minimum. If you run out of topics, work together to generate new areas to explore with one another. The overall goal is to get to know one another as well as you can. Please keep in mind, however, that if you do not wish to share information about some aspect of your life, it is perfectly fine to decline specific questions. Please respect one another in this regard. Also please remember that you may discontinue participation at any time. If you have any questions, please inform the investigator on-site. Thank you in advance for your participation [16, p. 173].

During the three breaks prior to sessions two through four, participants were taken to separate rooms to complete brief measures assessing each other group member on perceived control, as well as dyadic ratings for closeness and conflict. In addition, each participant completed a self-report version of each measure at pre- and post-test (for a complete description of the psychometric qualities of these measures, see [10] and for research materials, see [16]). Scores on these measures were not used in this study, but rather were intended to provide a plausible rationale for the false feedback to be delivered to one member as a method of inducing internal conflict.

Within the experimental groups, between one and four group members were induced with internal conflict. The conflict induction occurred between discussions two and three. In each case, the target(s) for induction was selected at random. During the induction, each target was asked to wait before returning to the group to allow for the tallying of scores from all members and an opportunity to see the scores she had earned based on the ratings of the other group members. After a 3 min wait, the principal investigator (PI) returned with a research assistant (RA), who handed the participant a score sheet with handwritten scores in red ink for each characteristic and descriptions for various ranges of scores. Scores were '17' for closeness, '33' for control and '83' for conflict, leading to feedback that was low on closeness and high on conflict (both indicating negative interpersonal styles) and moderate on control.

Each target was then given an additional 3 min to review the scores and descriptions, after which the PI and RA returned to obtain a manipulation check on the conflict induction, asking each target to record on the front of her score sheet a rating from one to five indicating the degree to which she felt the written descriptions were accurate with respect to her actual interpersonal style ('1' representing 'completely inaccurate', '3' as 'somewhat accurate' and '5' as 'completely accurate'). Handwritten scores in red ink were used in this manner in order to maximize participant vigilance to the induction and to the manipulation check. Across the six groups, there was one control group (no inductions), two groups with one member induced (the group from the pilot study and one replication group) and one group each with two, three and all four members induced. The goal was to obtain a range of conflict induction with sufficient variance across groups. Finally, just before leaving the individual room to return to the group, each induced participant was given specific verbal instruction not to discuss any aspect of their feedback with the other group members. This instruction was necessary in order to ensure that any conflict generated was coming primarily from internal processes within the individual member(s).

To allow for the possibility of conflict resolution during discussion four, the following instructions were read during the break between discussions three and four:

Feedback will not be given at this point in the discussion; however you may now feel free to discuss the results of your feedback with the other members if you so choose. Similarly, please feel free to discuss your prior responses openly with the other group members.

The degree of conflict resolution taking place during discussion four was assessed based on a 5-point observation-based scale derived from independent ratings made by the PI and two trained psychology undergraduate RAs. One point towards conflict resolution was earned based on each of the following observed sets of behaviour: (i) group members discussing the induction (i.e. false interpersonal feedback) for 1 min or more, (ii) expression of positive attitudes towards the target by two or more group members (e.g. 'We don't think you're cold or abrasive?'), (iii) expressing positive effect towards the target by two or more group members (e.g. positive tone or facial expression), and (iv) expression of suspicion by one or more group member about the validity of the feedback (e.g. 'Maybe they're tricking us?'). The three coders reached 100% agreement on the presence or the absence of each behaviour in discussion four. The resulting score was used to attenuate the level of induced conflict, depending upon the level of observed conflict resolution.

After the fourth discussion, participants were provided with two sets of manipulation check questions, one completed along with the self-report post-test (i.e. asking for their understanding of the goals of the study), and another more specific set (i.e. asking if they had suspected any deception during the experiment). Following this final manipulation check, participants were fully debriefed regarding the experimental manipulation and the aims of the study, and any additional questions were answered at that time.

### 3.2. Pattern analysis

Each utterance within each discussion was coded based on which member was speaking in time-sequence [10], resulting in a categorical time series composed of the first 308 utterances of each discussion. The number of utterances ( $n$ ) was limited to 308 to allow for consistency in calculations of entropy scores to allow for statistical comparisons across discussions, the shortest discussion being 308 utterances long (mean  $n$  across discussions = 503; range: 308–788). Each discussion was coded independently by two trained RAs. Cohen's Kappa ( $K$ ) values were calculated for all 24 discussions and ranged from 0.62 to 0.91 with mean of 0.76. Areas of disagreement for specific codes were reconciled through collaborative discussion, in most cases rather simply because disagreements most typically resulted from coder error rather than ambiguity (e.g. perfectly timed overlaps in speech). Noise in the measurement of entropy within the current methodology would most likely increase entropy values (i.e. increasing the number of low-recurrence patterns) and at high enough levels distort (truncate the tail) the IPL. As such, it is beneficial for comparisons of entropy across discussions that the values for  $K$  were generally high and consistent.

Orbital decomposition (OD) [7,9,11,17] was used to derive measures of entropy used in this study. OD is a type of symbolic dynamics analysis that 'decomposes' categorical time series into patterns of nominally coded strings. The standard algorithm increases string length one code at a time (in this case, one utterance at a time; e.g. patterns of 2, 3, 4 utterances and so on) to the maximum length prior to the drop in topological entropy to zero (the point at which there are no more immediate pattern recurrences). There is also  $X^2$  value calculated at each step, which can be used as an alternative method for determining the optimal string length ( $C$ ) to analyse the series. This study used a third



alternative, which is designed to allow for an ideal string length that is equal across groups [9]. The goal of this method is to balance the decreasing probability for recurrence as one increases  $C$  (e.g. patterns of length 20 would be extremely unlikely to repeat themselves even once) with the decreasing interpersonal meaning of very short patterns (i.e.  $C = 2$ ). Furthermore, it is ideal to keep  $C$  consistent across discussions to allow for analytic equivalence when making statistical comparisons across different groups. Therefore, two criteria were used to determine the optimal value for  $C$ : (i) to allow for a sufficient degree of pattern uniqueness, at least 25% of the patterns were to arise only one time during the discussion (the number of one-time patterns increases as  $C$  increases) and (ii) to allow for a sufficient degree of structure, at least one pattern was to recur a minimum of five times (the number of high-recurring patterns decreases as  $C$  increases). Based on these criteria, the optimal choice for a common string length across discussions was at  $C = 6$ . Using  $C = 6$ , each series was decomposed into patterns moving one utterance at a time across the entire series, yielding a total of 303 patterns for each discussion (built from 308 individual utterances).

OD also produces a calculation of Shannon's or information entropy ( $H_i$ ) for each string length. Information entropy is a well-known, and often used, measure of order versus randomness that is based in statistical mechanics. Information entropy was calculated for each discussion based on the following equation:

$$H_i = \sum_{i=1}^r p_i \left[ \ln \left( \frac{1}{p_i} \right) \right], \quad (3.1)$$

where  $p$  is the probability associated with each ( $i = 1$  to  $r$ ) categorical outcome of the observation of interest. Information entropy conveys the degree of novelty in a time series, with high levels of repetition yielding lower values, and lower repetition yielding higher values [14,15].

Next, the frequency distributions for all strings at length  $C = 6$  were analysed for fit with an IPL, and if appropriate for a measurement of fractal dimension. The presence of an IPL and calculation of fractal dimension were carried out using nonlinear regression to examine the slope of the curve defined by the number of different patterns ( $y$ -axis) at each level of recurrence ( $x$ -axis) as well as the fit of this curve to an IPL. An IPL is defined by an exponential relationship between size and frequency

$$Y = aX^{-b}, \quad (3.2)$$

where  $X$  is the number of recurrences for a given pattern (analogous to the *magnitude* of the recurrence phenomenon),  $Y$  is the frequency at which one observes each particular value of recurrence,  $a$  is an intercept and  $b$  is a nonlinear regression weight representing the shape of the IPL curve, which can be used as an estimate of fractal dimension. This shape parameter is identical to the slope of the log-log linear transformation of equation (3.2). In this application, it was predicted that there would be exponentially more low-recurrence patterns (i.e. few repetitions) compared with high-recurrence patterns for all discussions. The ratio between high- and low-recurrence patterns defines the shape of the IPL curve (i.e. fractal dimension). Steeper curves (i.e. higher fractal dimension values) indicate more low-recurrence patterns compared with high-recurrence patterns. The result is a greater variety of patterns, thus higher complexity within the discussion. By analogy, a tree with many more small branches compared with large ones would appear to have a more complex structure. Shallow curves, with longer tails (i.e. lower fractal dimension values), indicate greater structure (i.e. repetition) within the time series. By analogy, these curves would define a tree that is mostly trunk and thick branches, which appears as a more rigid structure. A high fit ( $R^2$ ) between the resulting curve and an IPL indicates that the recurrence structure within the discussion is fractal and is likely being generated through a process of self-organization.

### 3.3. Complexity across discussions

Standard scores for information entropy and fractal dimension were calculated for each of the four discussions within each of the six groups to allow for equivalence in comparisons of relative change in entropy due to level of conflict across groups. The levels of internal conflict ( $I_{con}$ ) for discussions 3 and 4 across the experimental groups were determined based on the number of members induced (from 0 to 4) attenuated by the level of conflict induction (1–5) prior to discussion three and the level of conflict resolution (1–5) during discussion four. Ratings were translated into quarter intervals, with 1 = 1 (e.g. complete induction), 2 = 0.75 (e.g. 75% induction), 3 = 0.50, 4 = 0.25 and 5 = 0. The highest possible value for conflict then was equal to 4, meaning that all four members were induced with manipulation check values equal to 1 (100% induction). The lowest value, 0, was automatically assigned for any discussion lacking induction, which includes discussions one and two across all groups and all four discussions for the control group.

The resulting scores for conflict were tested for bivariate correlation with standard scores (deviation from mean divided by standard deviation) for information entropy and fractal dimension across the 24 discussions.

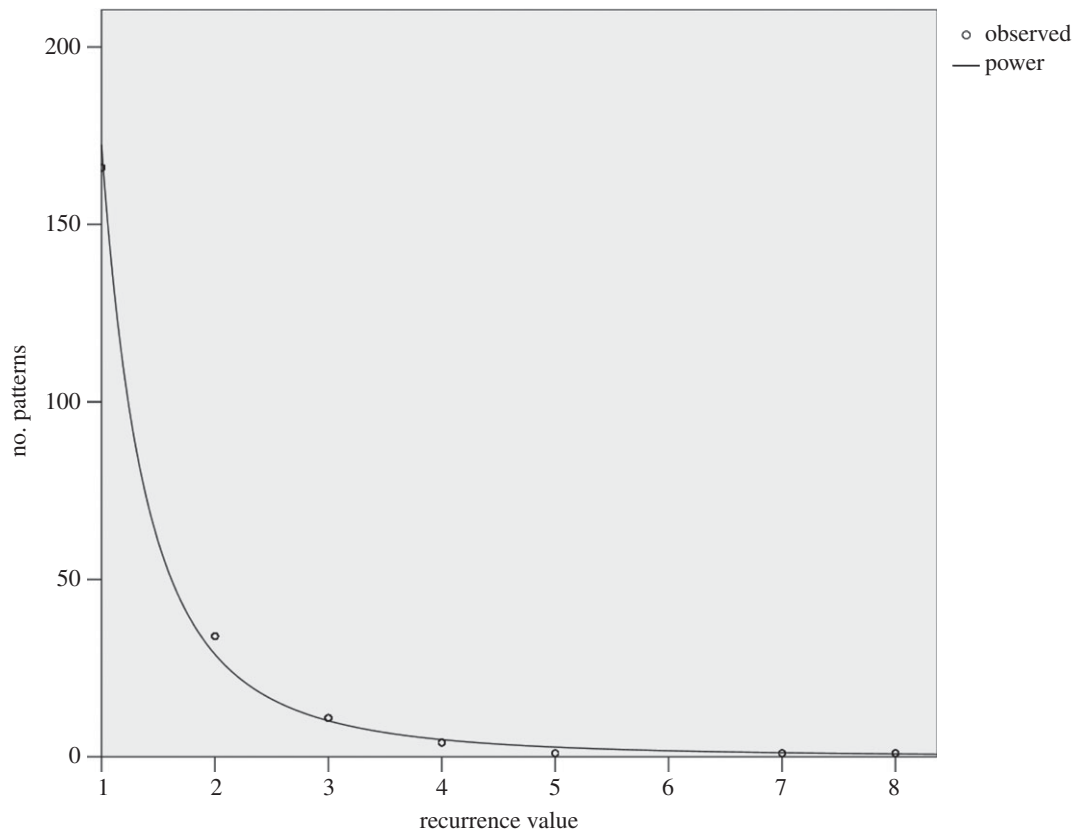
## 4. Results and discussion

### 4.1. Evidence for fractal structure and self-organization

The IPL model provided a strong fit to the recurrence structure for turn-taking patterns across all 24 discussions, with a mean  $R^2 = 0.94$  (range: 0.86–0.99). Fractal dimension was calculated for each discussion using the shape parameter for these IPL frequency distributions (equivalent to the slope of the log-log plot). The mean fractal dimension across discussions was 1.93 (range: 1.07–2.86). Self-organizing dynamics, with complexity levels at the edge of chaos are typically expected to exhibit IPL dynamics with fractal dimensions between one and two, with low-dimensional chaos typically exhibiting fractal dimensions of three or higher [18–20]. Altogether, these results strongly suggest that each of these experimentally created groups exhibited self-organizing conversation dynamics (albeit with some of the discussions residing close to the boundary for low-dimensional chaos), consistent with past studies of family [8,9] and therapy group dynamics [10]. Table 1 contains the values for each of the study-wide variables across the 24 discussions. Figure 1 contains an example IPL from Group 1's second discussion, where the IPL fit produced an  $R^2 = 0.99$  and where  $D_f = 2.57$ .

### 4.2. Experimental effects of conflict on group dynamics

To control for different baseline levels of complexity across the six experimental groups, standard scores were calculated for fractal dimension and information entropy based on each group's unique mean and standard deviation. As predicted, each complexity measure was negatively correlated with level of internal conflict across all discussions; fractal dimension  $r = -0.428$  ( $p = 0.037$ ,  $N = 24$ ) and information entropy  $r = -0.474$  ( $p = 0.019$ ,  $N = 24$ ). These aggregated experimental results are consistent with the pilot results previously reported by Pincus *et al.* [11] using only Group 1, suggesting that experimentally induced internal conflict to members of a group can cause self-organizing group dynamics to shift towards greater coherence and predictability, whereas resolution of that conflict can shift the dynamics back towards greater flexibility.



**Figure 1.** Example IPL curve for Group 1, discussion 2 ( $R^2 = 0.99$ ;  $D_f = 2.57$ ). The curve represents the frequency distribution of turn-taking patterns of length ( $C$ ) = 6, with the number of patterns ( $y$ -axis) at each level of recurrence ( $x$ -axis). As a point of reference, one may see that there were 166 patterns that occurred once (the mode), and one pattern that recurred eight times during the discussion (the tail).

**Table 1.** Values for induced conflict ( $I_c$ ), fit to IPL ( $R^2$ ), information entropy ( $H_i$ ) and fractal dimension ( $D_f$ ) for each of 24 discussions.

	discussion 1				discussion 2				discussion 3				discussion 4			
	$I_c$	$R^2$	$H_i$	$D_f$	$I_c$	$R^2$	$H_i$	$D_f$	$I_c$	$R^2$	$H_i$	$D_f$	$I_c$	$R^2$	$H_i$	$D_f$
Group 1	0	0.98	5.34	2.86	0	0.99	5.24	2.58	1	0.96	4.96	1.93	0.75	0.90	4.94	1.78
Group 2	0	0.94	4.96	2.04	0	0.86	4.26	1.08	0.75	0.94	4.24	1.40	0.75	0.97	4.75	1.81
Group 3	0	0.91	4.49	1.41	0	0.94	4.36	1.39	0	0.88	4.20	1.20	0	0.91	4.42	1.39
Group 4	0	0.96	4.93	1.89	0	0.95	5.08	2.14	2	0.90	4.32	1.48	0	0.94	5.12	1.95
Group 5	0	0.95	4.88	1.79	0	0.98	5.28	2.54	1	0.98	5.22	2.44	1	0.98	5.17	2.06
Group 6	0	0.96	5.28	2.51	0	0.97	5.16	2.33	2	0.96	5.09	2.18	0	0.95	5.16	2.19

Though statistically significant overall, the results were far from perfect within each group. As such, it is practical to briefly report the impacts of the intervention (or lack of intervention) across the discussions for each group (based on ANOVAs of information entropy values across four discussions with  $p$  set at 0.05). As was previously reported in the pilot study [16], Group 1 fitted the expected pattern of results, with a significant drop in complexity levels following the complete induction of one member and remaining low in discussion four, which lacked meaningful conflict resolution. Group 2, the single member induction replication attempt, failed to establish a consistent baseline and showed an increase in complexity in discussion four without any conflict resolution. Group 3 produced the expected results: with no member-inductions the group dynamics were equivalent

across all four discussions. The results of Group 4 were consistent with experimental predictions as well, with equivalent levels of complexity across the baseline, followed by a large and significant drop in discussion three after two members were completely induced, and a complete rebound to baseline levels as the induction was fully resolved in discussion four. In Group 5, the baseline was not established, as complexity jumped significantly from discussion one to discussion two and then remained consistent for remaining discussions, with no effect for the three members induced ( $2 \times 25\%$  and  $1 \times 50\%$ ). Finally, Group 6 followed the predicted pattern of drops and rebounds, with all four members slightly induced in discussion 3 ( $4 \times 50\%$ ) and complete resolution in discussion 4 (although the only significant difference was between discussion 1 and 3).

In sum, it appears that the significant aggregate results based on the correlation analysis across discussions rest primarily upon: (i) the drops in complexity following the induction in Groups 1, 6 and 4, (ii) the stability of complexity levels across discussions in the control group (Group 3), and (iii) the rebounding levels of complexity following resolution in Groups 4 and 6. The two groups that did not fit the expected results (Groups 2 and 5) were the two groups in which the baseline failed to establish itself across discussions one and two. Overall, this pattern of results suggests that internal conflict and resolution of that conflict may generally be sufficient to shift group dynamics; however, it does not do so invariably. Similarly, there must be other factors at play as well that are sufficient to spontaneously shift levels of group flexibility in either direction (e.g. closeness and control; see [10]).

## 5. General discussion and conclusion

These present results are consistent with a variety of other similar investigations using OD to quantify the dynamics of various types of groups (e.g. [8–10,16,17]). The primary theoretical advantage of establishing self-organization in general, and the IPL model in particular, as the mechanism underlying the regulation of group dynamics is the ability to apply broad interdisciplinary knowledge to understanding the structural, regulatory and evolutionary processes that underlie psychosocial resilience. Rather than building a micro-theoretical account of group dynamics in this or that context, one may build a broad and general theory of group processes that is consistent with the ubiquitous processes that determine self-organization across many natural systems.

One initial insight that may be made is that order emerges quickly within small groups within a matter of minutes. Such emergence occurs in a bottom-up fashion, simply through the exchange of information among members of a group [21]. Second, the fractal organization of the IPL suggests a regulatory function of the small group over time. Small groups self-organize towards a dynamical structure that is poised between order and chaos. Interpersonal dynamics are balanced as such, coherent and yet flexible and able to shift in either direction based on a variety of organizational demands—particularly conflict [22].

While the present results are an encouraging step in the direction of a deeper theoretical understanding of social resilience, the applied significance of the present results will require much additional work on a variety of fronts. First, although a statistically reliable negative relationship between conflict and complexity was found in general, the results were not monolithic across all groups. Furthermore, these are contrived experimental groups that are non-representative. Prior to applications in group assessment, specific norms for entropy levels across various groups and group contexts will need to be established. Most importantly, applied research will need to establish more specifically the relationship between interactive flexibility and group functioning, which was not a part of this study.

### 5.1. The nature of conflict and social resilience

The present results are consistent with prior work in this area demonstrating the central role of conflict in the regulation of self-organizing patterns of information exchange in

small groups [11,16,18,19]. When viewed within the broader context of conflict within social psychology research (see [16] for a full review) it appears that the rigidity that emerges in response to conflict is likely a short-term resilience response, allowing for an individual or interpersonal system to become more robust to the potentially destructive force of discrepant flows of information. Such an interpretation is in line with the notion that resilient systems are *meta-flexible*, with the ability to shift between rigidity and flexibility in response to shifting challenges to structural integrity [23].

As a relatively novel methodology for analysing group dynamics, it is worthwhile to highlight some of the most important methodological limitations of this work. First, any study measuring entropy in group dynamics is limited by the actual dynamical events that are captured, which rest in the chosen coding scheme. The present scheme aimed at turns-at-speech because it is both simple yet also practical (e.g. within family therapy contexts [8]). Different schemes will produce different results, with either minor or major differences, and may be better or worse depending upon the research questions and context.

Furthermore, it is always important to consider any source of error in coding that might inflate entropy levels, obscure actual patterns that exist, or that may systematically bias entropy measures across different experimental conditions. The fact that each complexity measure is entirely dependent upon pattern frequencies requires researchers to consider their definition of patterns. For example, within this study, patterns involving simple back-and-forth turns at speech between two members were not treated any differently than more complex patterns involving three or four members. Depending upon the context and goals of a study, such distinctions may be considered to be important.

Future research using the present paradigm must continue to consider the most optimal methods for maintaining consistency across groups to allow for controlled comparisons. For example, within the present context, group equivalence was maintained by using only the first 308 verbal statements in each discussion. A great number of alternative strategies are available in each of these areas, and may be more appropriate depending upon the specific research context. Finally, one must make a choice about how to treat time. This study used event-based sampling (i.e. turns-at-speech), irrespective of actual time. Numerous other options exist as well [9].

Beyond the coding scheme, a number of design challenges exist when attempting to make comparisons across groups using complexity measures. The use of the omnibus correlation to examine the relationship between conflict and entropy across groups may be challenged on the grounds that it makes use of non-significant shifts in entropy values that may have occurred within individual groups (e.g. Group 6). By contrast, however, the use of ANOVA to examine changes in the single group experimental paradigm is limited by the fact that mean and variance necessarily correlate in measures of information entropy and fractal dimension. It may be successfully argued that this limitation may be overcome (or at least overlooked) in situations in which the degree of variance in entropy values across conditions is not too high [16]. However, this limitation should always be taken into consideration when one is deciding whether to use statistics that rely upon mean comparisons (e.g. ANOVA) and those that do not (e.g. regression).

## 5.2. Applications to measuring, understanding and improving group resilience

Although preliminary in nature, the present results help to validate a number of aspects of clinical wisdom from individual, group and family therapy practice that may be applied to understanding and increasing psychosocial resilience. First, the reliable tendency for the mild internal conflict induction used here to spread and impact group dynamics is noteworthy. Logically, these effects support the notion that highly conflicted individuals can exert major shifts to their interpersonal environments—one bad apple can indeed spoil the bunch. Within a military or other team context, for example, the internal conflicts of one team member may be sufficient to impact the dynamics of the team as a whole—both on the battlefield and also on the home-front upon reintegration within a family unit.

Interventions aimed at helping resolve psychosocial conflicts should take note of the functional role that rigidity–flexibility appears to play in social resilience. The repetitive nature of conflict interaction patterns is likely inevitable, and also adaptive to some extent as the psychosocial system braces itself against a threat to structural integrity. When a system gets stuck in this process of rigidity, professional interventions generally must serve the dual purpose of providing a strong *holding environment* to protect the integrity of the psychosocial system while also working to increase the awareness, openness and flexibility of the group members as they work towards conflict resolution. Through this theoretical lens, clinicians may gain a deeper appreciation for the nature of conflict, not as the enemy, but rather as a necessary resilience-making process in psychosocial health.

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