

Dialectic Behavior Therapy for Young Adults' Parents and Guardians: Analysis of the Common Unconscious Orientation

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Abstract

Introduction: This study investigates the emergence of common behavior in a slow-open group undergoing Dialectical Behavior Therapy (DBT) skills training. Participants were parents of adolescents enrolled in DBT programs. **Methods:** Participants completed an “absurd questionnaire” consisting of 50 pairs of images, selecting one image per pair. A baseline questionnaire was administered prior to group participation. We analyzed the distribution of responses across sessions, focusing on temporal evolution, correlation structure, and entropy. Empirical data were compared with Monte Carlo null models obtained by permuting session order, individual identities, and responses. **Results:** The distribution of responses exhibits a structured temporal evolution characterized by a dominant low-dimensional mode, which is significantly reduced under time permutation. This indicates that coordinated temporal dynamics contribute substantially to the observed structure. In contrast, randomizing individual identities increases both entropy and the magnitude of the dominant mode, suggesting that persistent individual response patterns constrain the emergence of collective dynamics. Transition-based measures show weaker or non-significant structure. **Conclusions:** The results indicate the presence of a temporally coordinated group-level dynamic that cannot be fully explained by

independent individual behavior. While compatible with interpretations based on group dynamics, these findings do not uniquely support any specific theoretical framework.

Keywords

Group Dynamics, Collective Behavior, Entropy Analysis, DBT (Dialectical Behavior Therapy)

1. Introduction

This paper is a continuation of our investigation into group dynamics (Fernandez-Rivas et al., 2020; Trojaola Zapirain et al., 2019; Trojaola Zapirain et al., 2014, 2015, 2016). In our previous work, we explained the rationale and assumptions of our research; therefore, we will provide only a brief reminder here. Our aim is to evaluate the presence and evolution of common behavior among participants in three groups following training in Dialectical Behavior Therapy (DBT). Two groups consisted of younger and older adolescents and were semi-open, whereas the third group was open and included the parents or guardians of adolescents in the first two groups, as well as some parents of adolescents who did not participate in any group. In this study, we consider only the slow-open parent group. The analysis of and comparison with the adolescent semi-open groups will be the subject of a future publication. In group terminology, a closed group is defined by a fixed membership established at the outset, with no subsequent admissions. In contrast, an open group permits participants to join and leave freely throughout its duration. A semi-open group is an intermediate configuration in which new participants may be admitted during the group's course, but only under predefined and controlled conditions.

The instrument used to evaluate the groups' common behavior was the "absurd" questionnaire described in our previous publications and briefly explained below. This work concentrates on the parents' group. We will analyze the adolescents' groups in a further publication.

DBT (Linehan, 1993, 2015; Miller et al., 2006) has been demonstrated to be an effective transdiagnostic treatment for adolescents whose main symptoms are emotional dysregulation and impulsivity. A complete program based on this therapy has been implemented in the Psychiatric Service of Basurto University Hospital (Bilbao, Spain). DBT involves several components, including skill training groups for adolescents and parents.

The British psychoanalyst Wilfred Bion described universal rules ("basic assumptions") governing the behavior of small-sized groups (Bion, 1961; Foulkes, 1964; Vergopoulos, 1983). Other psychoanalysts extended Bion's work, positing a "group psychic apparatus" and the group nature of the individual psyche (Anzieu & Kaës, 1975; Foulkes, 1964; Kaës, 1993, 2010).

Following this approach, when observing a group, we should regard the behavior of its members not only as the expression of separate entities, but also as the expression of a single (psychical) entity. The scope of our work is to characterize this “common behavior” in a quantifiable manner.

This experiment aims to detect potential unconscious connections among group members by observing their effects on participants’ responses to a questionnaire. The authors hypothesize that the group environment could “amplify” individual relations between members’ unconscious processes, rendering their effects detectable at the macroscopic level. As in some previous studies, we introduce a “questionnaire zero” to measure the initial socio-cultural bias before group interaction.

2. Materials and Methods

2.1. Participants

The data were collected from three groups: two semi-open groups composed of adolescents participating in DBT skills training, and one slow-open group composed of some of their parents and guardians, as well as parents of adolescents who did not participate in any group, but who also followed DBT skills training. As noted earlier, this paper focuses on the parents’ group. Table 1 presents the demographic characteristics of the groups.

Table 1. Demographic, social, and group composition of the participant sample, with the age of participants in each group, adolescents, and members of their families.

Parameter	Parents
Total	18
Female	10
Average age	50.5
1Q - 3Q	47.5 - 54.8
Undergrad education	2
Graduate education	8
Postgraduate education	10

The study commenced after the Basurto University Hospital Ethics Committee (Bilbao, Spain) approved the protocol, in accordance with the Helsinki Declaration on research involving human subjects. All participants provided written informed consent after receiving oral and written information about the experiment; for adolescents, both the participant and their parents or legal guardian signed the informed consent. All participant data were coded to ensure complete anonymity, including for the researchers analyzing the data.

2.2. Procedure

The skills taught in these groups include mindfulness, distress tolerance, emotion

regulation, interpersonal effectiveness, and walking the middle path.

The group of parents consisted of 10 DBT sessions. Each session lasted 1.5 hours and was held approximately weekly from the 14 of October 2022 to the 16 of June 2023. New parents can join during sessions 1 and 6. A total of 18 people participated in the group over its duration, and 25 sessions were held. The questionnaire was administered at each session. **Table 2** reports the session dates and the participants in each session. Note that the date of session 0—the questionnaire administered before entrance in the group—is set arbitrarily one month before the group’s first session.

Table 2. Session number, date, number of enrolled and present participants. Note. The date of Session 0—the questionnaire administered before entry into the group—was arbitrarily set one month before the first group session.

Session	Date	Enrolled	Present	Session	Date	Enrolled	Present
0	14/09/22	18	18	13	03/03/23	5	5
1	14/10/22	8	8	14	10/03/23	5	3
2	21/10/22	8	7	15	24/03/23	5	5
3	04/11/22	7	7	16	31/03/23	5	4
4	11/11/22	7	6	17	21/04/23	4	2
5	18/11/22	7	5	18	28/04/23	4	3
6	02/12/22	9	8	19	05/05/23	4	3
7	16/12/22	9	7	20	12/05/23	4	3
8	13/01/23	8	6	21	19/05/23	5	3
9	27/01/23	8	8	22	26/05/23	5	5
10	03/02/23	7	7	23	02/06/23	5	5
11	10/02/23	4	4	24	09/06/23	5	2
12	24/02/23	5	5	25	16/06/23	5	5

Before joining the group, all participants (adolescents and parents) attended an interview to obtain information and evaluate the group’s methodology and research. During that interview, participants completed the informed consent form and the questionnaire numbered “zero”.

An identification code was assigned to each participant to maintain their anonymity in the research. We have described the general experimental setting in previous publications (Fernandez-Rivas et al., 2020, 2021; Trojaola Zapirain et al., 2019; Trojaola Zapirain et al., 2014, 2015, 2016). It suffices to recall that we used a questionnaire comprising 50 pairs of figures for this work. Participants were asked to select one picture from each pair and complete the questionnaire within three minutes. The selection of images is intended to minimize sociocultural bias introduced by a word questionnaire (Zanello et al., 2004). The figures in each pair were always the same, but the pairs were randomly reshuffled at each test repeti-

tion to minimize mnemonic effects. **Figure 1** shows a sample page from the questionnaire with fictional picture choices.

Participation in the parent group has been somewhat uneven across the groups (see **Figure 2** and **Figure 3**).

2.3. Data Analysis

We indicated the most frequently chosen picture in each pair in the “zero” questionnaire, administered before the first group, as picture A ($A_i, i = 1.50$), while the other picture as B ($B_i, i = 1.50$). We have computed frequency tables for each image pair and for each session across the three groups. Because the present work

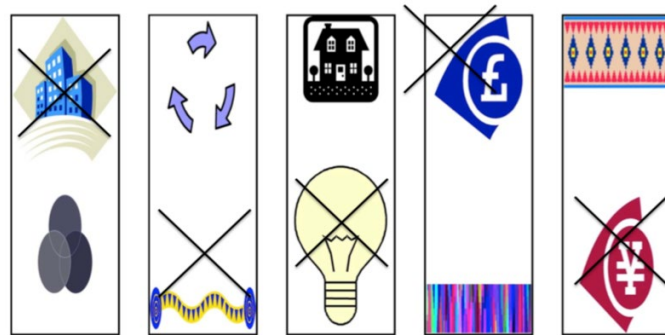


Figure 1. A page from the questionnaire with “fake” answers.

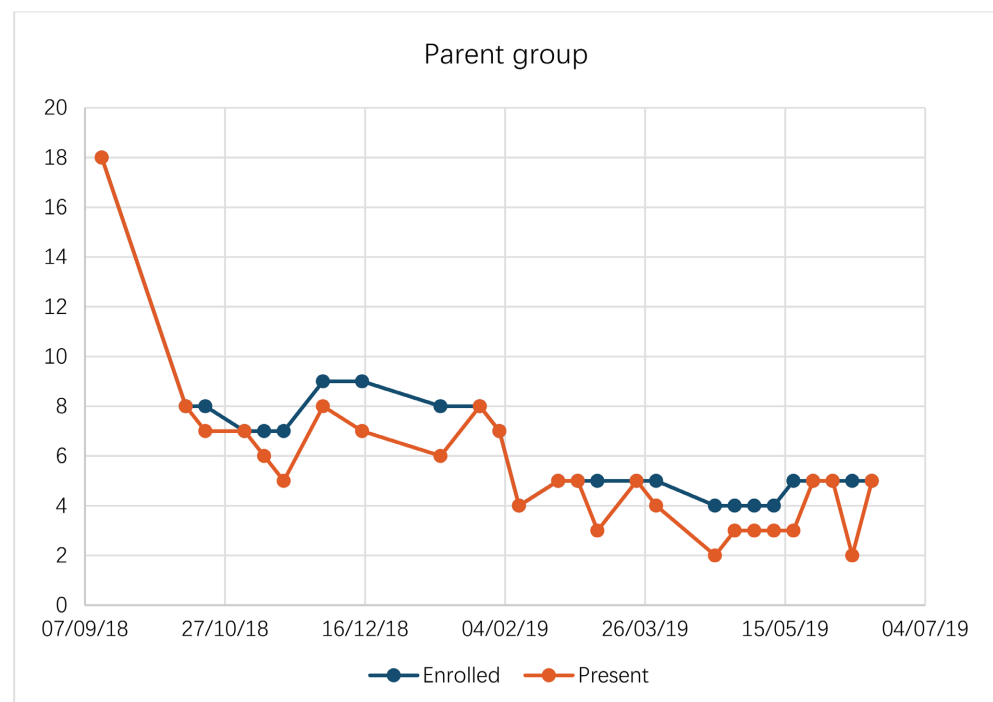


Figure 2. Parents enrolled and present in the group. The first point is set arbitrarily one month before the group’s first session and represents the first questionnaire administered to each individual before the group began. The parents’ group is a semi-open group that new parents can join during sessions 1 and 6. Therefore, there were not 18 parents at the start; rather, that is the total number of parents who participated in the group over its duration.

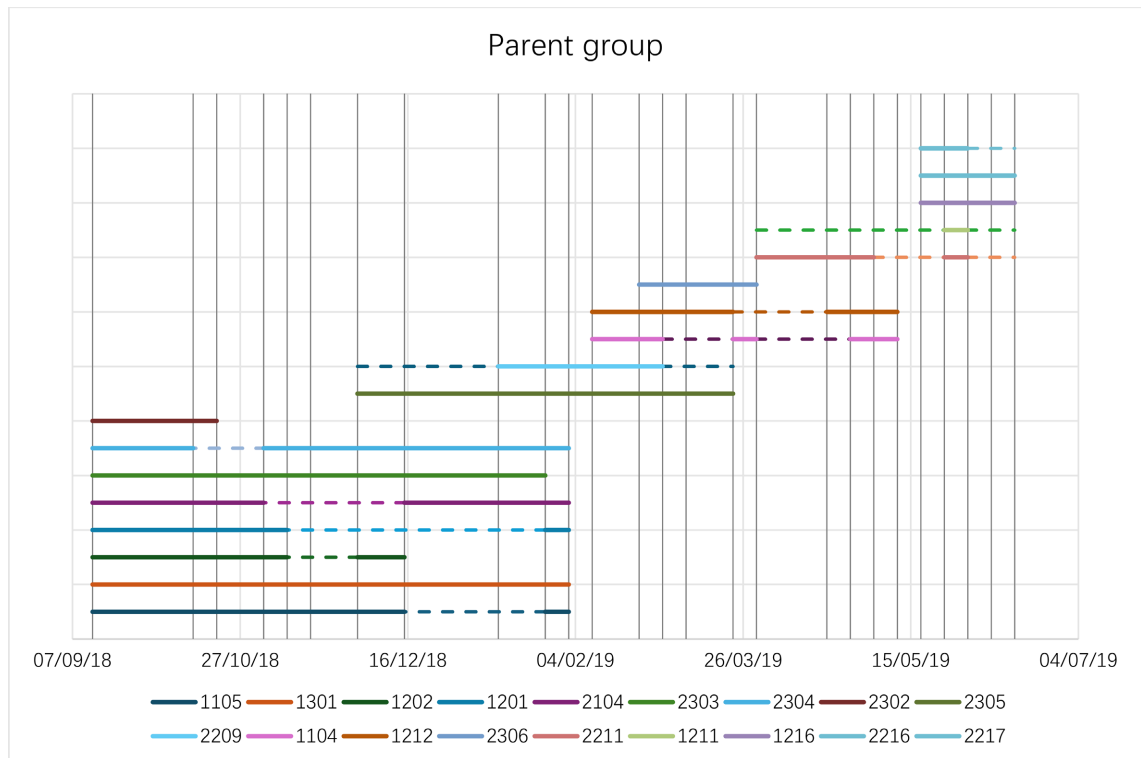


Figure 3. Timeline of the parent participation in the group. Individual parents are represented by a code. Dashed lines represent absences from the group. Vertical grey lines are the dates at which group sessions were held.

focuses on the influence of the group unconscious on the measured effects—i.e., the answers to the questionnaire—we consider only the proportion of participants choosing picture A or B for each of the 50 questions, regardless of how an individual participant's choice evolved.

Given the uneven participation, we decided not to impute data for individuals who were absent for a whole session. Some of the answers were missing or unreadable, and we corrected them using an LOCF (Last Observation Carry Forward) algorithm (Hamer & Simpson, 2009), using the same answer from the previous session. If the immediately preceding session was unavailable, the closest earlier session was used. If the invalid answer was in the first session, because no previous observation was available, the missing value was replaced by a random choice between the two options to avoid introducing directional bias. The total number of corrections is reported in Table 3.

Table 3. Corrections to the data with LOCF.

Group	Total valid answers	Answers corrected with LOCF	%
PG1	7530	25	0.3%

Given the very small amount of missing data, we felt that the LOCF method was appropriate, since it supposes stability in a participant's response. This correction has the potential to introduce statistical bias.

Due to the group's slow-opening nature, attendance has been very uneven. We acknowledge that this limits the statistical reliability of the results, and we have taken particular care to report the sample size at each session (see **Table 1**). We have considered removing very small samples, and indeed, as explained below, for the transitions we have considered only sessions with at least four participants. For other analyses, in particular the correlation matrix, we have decided to keep all sessions, considering that including small statistics is more informative than removing a point in the time sequence. We, however, realize that the limited and variable statistics are a limitation of our paper, and we hope to repeat a similar analysis in the future on a more complete statistical sample.

The semi-open nature of the group may indeed be problematic. However, the individual-permutation Monte Carlo specifically disrupts participant continuity while preserving the overall temporal structure of the sessions. The persistence of the main findings under this perturbation suggests that the observed collective structure cannot be reduced solely to the continuity of individual participants.

3. Results

3.1. Evolution of the Most Chosen Picture

We first study the evolution of the A's frequencies (the most chosen picture in questionnaire zero), defined as:

$$q_{ij} = \frac{N_{ij}^A}{N_{ij}}; \quad i \in \{1, \dots, 50\}, j \in \{0, \dots, 25\}$$

for the three groups during the training, where i is the question number and j is the session number. All data analysis was conducted using R (R Core Team, 2020). In **Figure 4**, we report the evolution of the average frequency of the parents' A

choice, defined as $q_j = \frac{1}{50} \sum_{i=1}^{50} q_{ij}$, across the different sessions.

A Friedman test was applied to the 50×26 question-by-session matrix, treating questions as blocks and sessions as repeated conditions. The test yielded a highly significant effect ($\chi^2(25) = 90.8, p = 2 \times 10^{-9}$), indicating that the distribution of A frequencies varies with time across sessions. We further performed a detailed analysis of the difference between consecutive sessions, using a Conover (Conover, 1999; Conover & Iman, 1979) post-hoc test with the Holm correction (Holm, 1979). This analysis does not reveal any significant transition. Over time, there seems to be a progressive drift away from the initial choice, with a reversal toward it at the end when a new set of parents enters the group. The entrance of a new group seems to reinforce the initial sociocultural bias, and the then "drifting" behavior recurs. If we compare the first and last sessions using the Wilcoxon signed-rank test, we obtain a highly significant p-value ($Z = -4.1, p = 4.5 \times 10^{-5}$), consistent with what suggested by the picture and the result of the global Friedman test.

To further investigate the temporal ordering across sessions, we performed Page's L test (Page, 1963), a nonparametric extension of the Friedman test de-

signed to detect ordered alternatives in repeated-measures designs when a priori ordering of the conditions exists. Again, questionnaire items were treated as blocks and sessions as ordered conditions. The test evaluates whether the median response across items follows a monotonic trend over sessions. Page's L test is highly significant ($Z = -6.4$, $p = 1.5 \times 10^{-10}$), indicating an ordered temporal evolution across sessions as visually suggested by **Figure 4**.

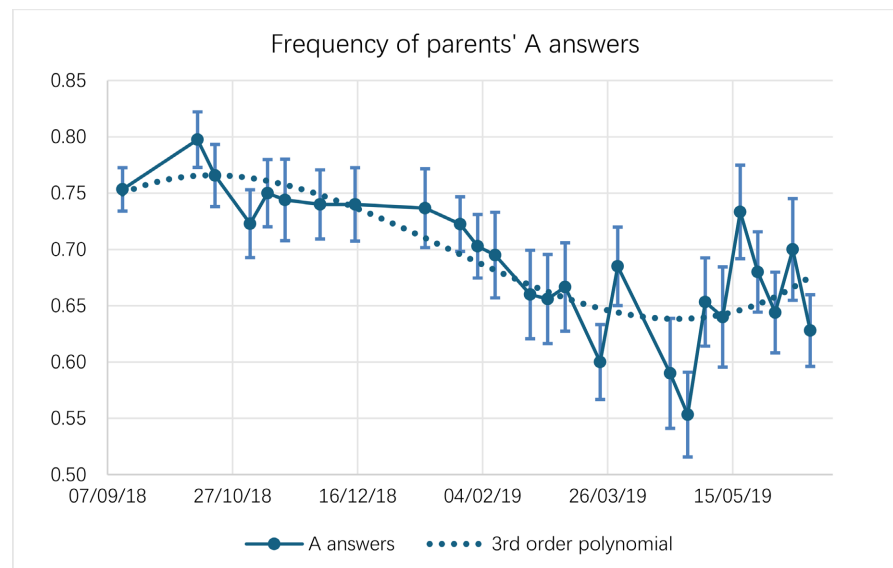


Figure 4. Evolution of the choice of A, q_i , for the parents during the training versus the session number. The dotted line is a 3rd order polynomial interpolation to guide the eye.

We used Friedman and Page's L nonparametric test because we have matched pairs for each block of answers (the frequency of A's for each question), the variable was numeric, and the participants were randomly sampled. Measurements across sessions are dependent since subjects participate in more than one session. We have preferred the Friedman test to ANOVA because our measurements, based on poor statistical results, do not follow a Gaussian distribution.

It is important to note that while Page's L test indicates the presence of a temporally ordered trend, this alone does not imply a reduction in effective dimensionality. Independent items undergoing similar monotonic evolution can produce apparent correlations across sessions without reflecting a genuinely low-dimensional structure. By this, we mean a structure that can be conveniently captured by a number of variables smaller than its theoretical degrees of freedom.

To probe the effective dimensionality of our data, we computed the 26×26 correlation matrix between sessions, with each session represented by the 50 A frequencies q_{ij} . The eigenvalue analysis of this matrix determines whether the observed temporal evolution is effectively captured by a small number of collective modes, rather than by independent yet similarly directed changes across items.

To further explore the nature of the observed eigenvalue structure, we con-

structured two Monte Carlo null models designed to selectively disrupt different sources of dependency. In the first Montecarlo, session labels were randomly permuted, breaking temporal alignment across measurements while preserving the marginal distribution of each item. In the second, individual identities were permuted within each session, preserving the cross-sectional covariance structure at each time point but destroying subject-level continuity across sessions. **Figure 5** shows the correlation matrix eigenvalues (scree plot). The purple and cyan dashed lines are the limits of the eigenvalue distribution under the Marchenko-Pastur Law (Götze & Tikhomirov, 2004), which describes the asymptotic behavior of the eigenvalues of large rectangular random matrices. We use the Marchenko-Pastur bounds as a reference corresponding to the limiting case of uncorrelated fluctuations.

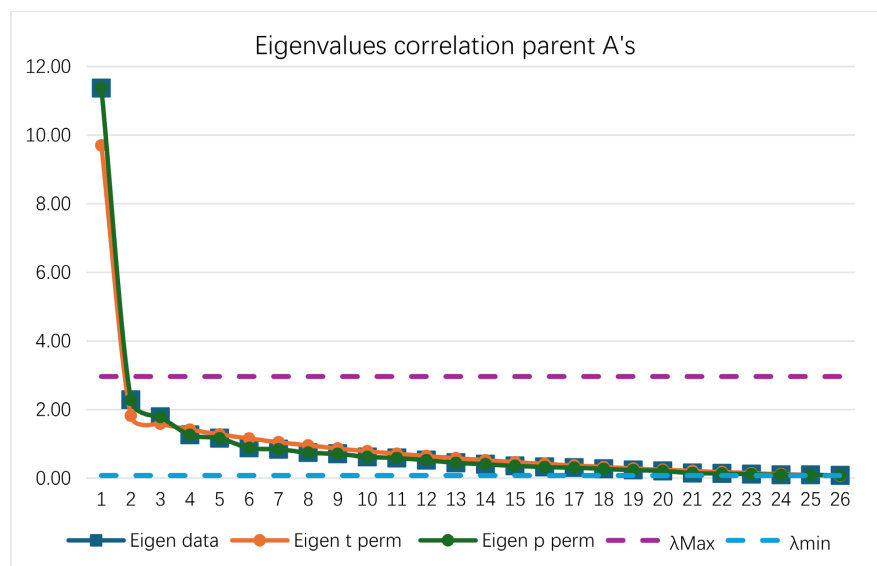


Figure 5. The blue curve is the eigenvalue spectrum of the correlation matrix computed from parents' A response frequencies. The purple and cyan dashed lines indicate the lower and upper bounds predicted by the Marchenko-Pastur distribution for random correlation matrices of comparable dimensions. The red curve shows the eigenvalue spectrum permuting session labels, thereby disrupting temporal alignment while preserving item-wise marginal distributions. The green curve corresponds to permutations of individuals within each session, preserving cross-sectional structure at each time point while eliminating subject-level continuity. In both cases, the displayed spectra are averaged over repeated Montecarlo realizations.

The trace of a correlation matrix is equal to its dimension, as all diagonal elements are equal to one. The leading eigenvalue in our data is 11.37, accounting for 43.7% of the total variance. Such a concentration of variance in a single mode is not expected under independent random fluctuations, as confirmed by comparison with a random-matrix baseline across questions.

The first null removes coherent temporal structure, whereas the second preserves instantaneous correlations but eliminates longitudinal consistency at the individual level. Importantly, these null models do not enforce independence; in-

stead, they provide baselines in which constraints linking observations across time or individuals are relaxed. For each null model, 4000 realizations were generated, and the corresponding covariance matrices were computed, yielding average eigenvalue spectra.

Figure 5 shows the correlation matrix eigenvalue plot for both simulations. Permuting individual labels within each session yields a spectral distribution that is numerically indistinguishable from the empirical one, consistent with the preservation of cross-sectional correlations under this null model. In contrast, permuting the session dates yields a substantially reduced leading eigenvalue ($\lambda = 9.70 \pm 0.08$, $Z \sim 21$, $p < 0.001$), indicating that the observed dimensional reduction is strongly enhanced by the synchronized temporal evolution across questionnaire items. This is consistent with the visual trend of **Figure 4** and the results of the Page's L test.

To further investigate the relationship between the empirical data and the null models, we introduced a third Monte Carlo procedure in which individual responses to questionnaires 1 - 25 were replaced by Bernoulli draws with probabilities matching the observed individual averages. We generated 2000 realizations and analyzed the resulting eigenvalue spectra. The dominant eigenvalue of the A distribution under this null model is $\lambda = 8.21 \pm 0.44$ ($Z = 7.18$, $p = 6.9 \times 10^{-13}$), significantly lower than the empirical value. This result indicates that the observed dominant mode cannot be fully explained by static individual response tendencies and provides evidence for an additional coordinated temporal structure in the data beyond the initial sociocultural bias.

3.2. Evolution of the Transitions between Questionnaires

We now consider how the choice of A and B has evolved by comparing changes in participants' picture selection. For each pair of successive sessions, we count the number of participants whose choice has changed from A to B and from B to A. We label this *transition* by the number of the second session, i.e., we denote the transition ($A \rightarrow B$ or $B \rightarrow A$) between sessions $j - 1$ and j by j , therefore $j \in \{1, \dots, 25\}$. Because in slow-open groups the number of participants varies across sessions, we consider only the individuals present in both sessions j and $j-1$ and calculate the transition frequencies as:

$$g_{i,j}^{A \rightarrow B} = \frac{\#\{A_{i,j-1} \wedge B_{i,j}\}}{\#\{\text{present at } j-1 \text{ and } j\}}; \quad g_{i,j}^{B \rightarrow A} = \frac{\#\{B_{i,j-1} \wedge A_{i,j}\}}{\#\{\text{present at } j-1 \text{ and } j\}}$$

$$i \in \{1, \dots, 50\}, \quad j \in \{1, \dots, 25\}$$

Given that the objective of the analysis is to evaluate how group exposure modifies the participant's pre-group orientation, questionnaire 0 was used as the personal reference state. The first observed state at entry was compared with questionnaire 0.

Figure 6 shows the average transition frequencies from $A \rightarrow B$ and $B \rightarrow A$ define as:

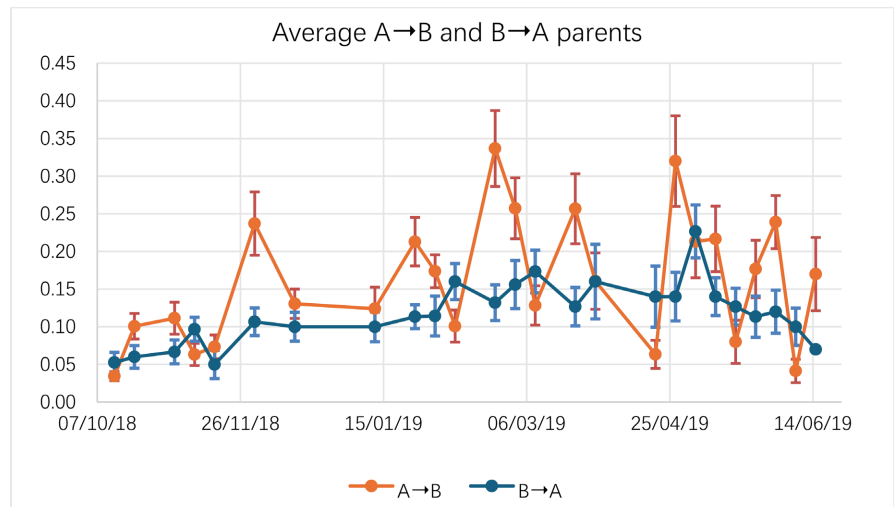


Figure 6. Evolution of the average change of choice frequency $A \rightarrow B$ and $B \rightarrow A$ for the parent group versus session date.

$$g_j^{\{A \rightarrow B, B \rightarrow A\}} = \frac{1}{50} \sum_{i=1}^{50} g_{i,j}^{\{A \rightarrow B, B \rightarrow A\}}; \quad j \in \{1, \dots, 25\}$$

A Friedman test on the 50×25 questions by $A \rightarrow B$ transition frequencies matrix is highly significant ($\chi^2(24) = 74.6$, $p = 4.4 \times 10^{-7}$), and the same is true for the $B \rightarrow A$ transition matrix ($\chi^2(24) = 76.3$, $p = 2.3 \times 10^{-7}$). To identify potentially significant transitions between couples of sessions, we performed a Conover post-hoc test using the Holm correction, but only between those sessions with at least four participants each. This analysis revealed no significant differences between consecutive transitions, suggesting gradual variation across sessions without abrupt shifts or coordinated directional changes. The Page's L tests for the two curves are non-significant, indicating no clear temporal tendency of the transition frequencies.

Figure 7 shows the spectral analysis of the correlation matrices for the $A \rightarrow B$ and $B \rightarrow A$ transition frequencies. The eigenvalue spectrum of the empirical data lies within the Marchenko-Pastur bounds, suggesting the absence of a dominant mode. Permuting the session labels yields similar eigenvalue distributions. The dominant eigenvalues of the empirical data for the $A \rightarrow B$ ($\lambda = 2.6$) and $B \rightarrow A$ ($\lambda = 2.48$) distributions are compatible with those of the respective time-permuted MonteCarlos (2.52 ± 0.15 and 2.63 ± 0.16), indicating the absence of a strong time-dependent structure.

If we now compare the empirical covariance matrix spectral distribution to that obtained by permuting the individuals within each session, we observe a dominant eigenvalue that is significantly larger than both the Marchenko-Pastur limit and the empirical and time-permuted dominant eigenvalues. In particular, for the $A \rightarrow B$ transitions, the dominant eigenvalue for the individual permutation MonteCarlo is $\lambda = 4.00 \pm 0.28$ ($Z = -5.00$, $p = 5.73 \times 10^{-7}$) and for the $B \rightarrow A$ transitions, the first eigenvalue of individual permutations is $\lambda = 3.71 \pm 0.29$ ($Z = -4.24$, $p =$

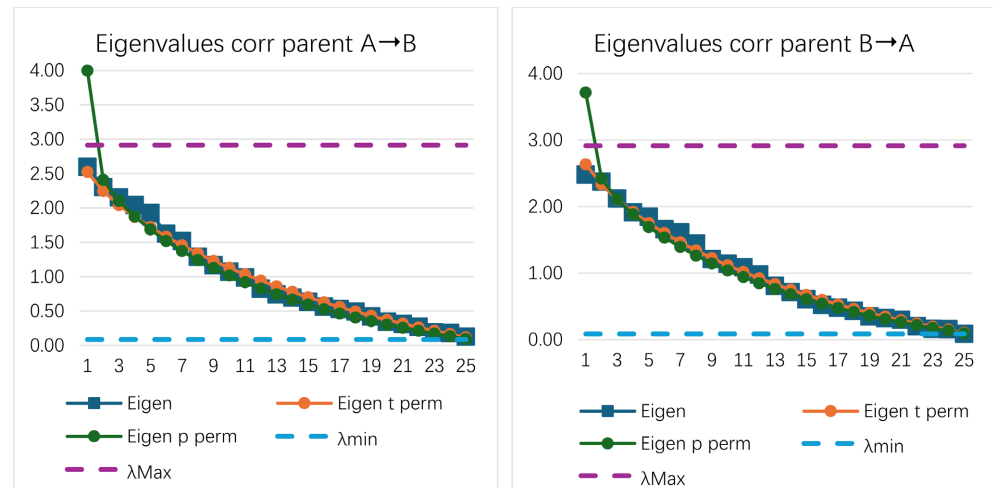


Figure 7. Spectral analysis of the correlation matrices for the transitions $A \rightarrow B$ and $B \rightarrow A$. The purple and cyan dashed lines indicate the lower and upper bounds predicted by the Marchenko-Pastur distribution for random correlation matrices of comparable dimensions. The blue lines are the empirical data. The red curve shows the eigenvalue spectrum obtained from Monte Carlo realizations in which session labels were permuted, thereby disrupting temporal alignment while preserving item-wise marginal distributions. The green curve represents permutations of individuals within each session, preserving the cross-sectional structure at each time point while eliminating subject-level continuity. In both cases, the displayed spectra are averaged over repeated realizations.

2.24×10^{-5}). In other words, by destroying individual coherence across sessions, we enhance a dominant mode in the choice transitions by redistributing variance across different modes.

As done for the A distribution, we calculated the transitions with the Bernoulli random draws. For the $A \rightarrow B$ transition we obtained a dominant mode of $\lambda = 2.71 \pm 0.18$ ($Z = -0.61$, $p = 0.54$) and for the $B \rightarrow A$ transitions we have $\lambda = 2.71 \pm 0.18$ ($Z = -0.90$, $p = 0.20$). In contrast to the A distribution, the transition dynamics do not show a significant deviation from the Bernoulli null model, suggesting that the observed collective structure is primarily reflected in the distribution of states rather than in directional transition asymmetries.

3.3. Evolution of “Flux” and “Focus”

To further investigate the changes, we calculate two complementary quantities derived from the transition frequencies: the total flux of changes between two sessions, and the focus, which measures the tendency to move toward the initial choice. These two quantities are defined as:

$$focus_{i,j} = g_{i,j}^{B \rightarrow A} - g_{i,j}^{A \rightarrow B}; \quad flux_{i,j} = g_{i,j}^{B \rightarrow A} + g_{i,j}^{A \rightarrow B}$$

$$i \in \{1, \dots, 50\}, \quad j \in \{1, \dots, 25\}$$

Figure 8 shows the average over the 50 questions of these two quantities versus session date. The Friedman test for the 50 questions times 25 transitions flux matrix is highly significant ($\chi^2(24) = 110.1$, $p = 4.4 \times 10^{-13}$), but, again, the Conover post-hoc with Holm correction test with at least four participants fails to find sig-

nificance between adjacent transitions. This confirms the observation of a group dynamic without sharp phase transitions. The Page's L test shows a significant trend ($Z = 3.8$, $p = 1.5 \times 10^{-4}$). As shown in **Figure 8**, the average flux appears to increase toward the middle sessions and then stabilize, without returning to the initial value.

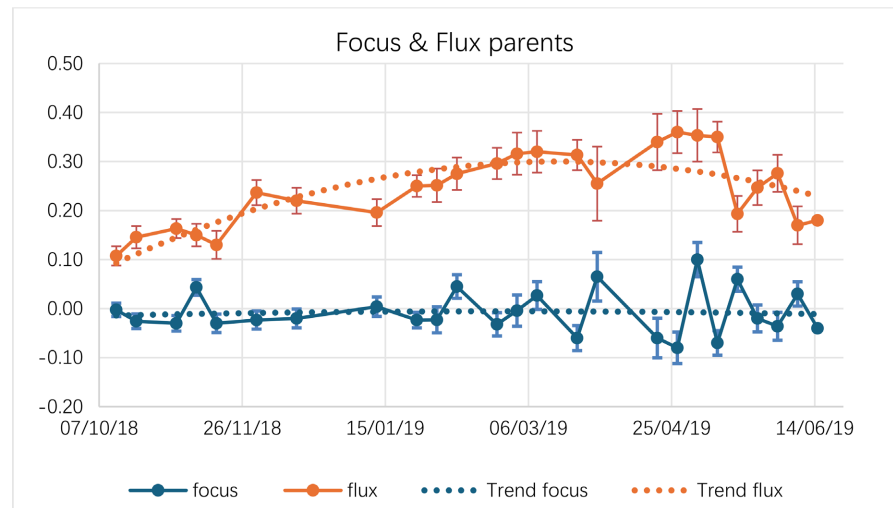


Figure 8. Average flux $flux_{i,j} = g_{i,j}^{B \rightarrow A} + g_{i,j}^{A \rightarrow B}$ and focus $focus_{i,j} = g_{i,j}^{B \rightarrow A} - g_{i,j}^{A \rightarrow B}$ of the choice's transition between different sessions versus the session date. The trendlines are 2nd-degree polynomial fits to guide the eye.

The Friedman test for the focus is significant ($\chi^2(24) = 37.6$, $p = 0.04$), but, again, the Conover post-hoc test with Holm correction between adjacent transitions with at least four participants fails to detect significance, indicating an evolving group dynamic without phase transitions. The Page L's test does not detect an ordered tendency ($Z = 0.5$, $p = 0.6$). These results are difficult to reconcile with the A-frequency dynamics, which show a clear time-dependent trend. However, this should not be over-interpreted. Because the focus is defined as the difference between two (positive) transition frequencies, its variance is amplified relative to that of each component taken separately. Moreover, the requirement that at least four participants be present in both sessions reduces the effective sample size, making this quantity particularly sensitive to noise.

As a consistency check, we compared the evolution of the average A frequency with the curve obtained by summing the average focus values to the initial average A frequencies (**Figure 9**), defined as “accumulated focus”. The two curves show a broadly similar behavior, suggesting that the integrated focus reflects, at least qualitatively, the global drift of responses.

The agreement is only approximate. Differences arise both from the reduced and variable sample size – since focus can be computed only for participants present in consecutive sessions – and from the higher sensitivity of this quantity to noise.

We then applied the correlation matrix and eigenvalue analysis to both derived quantities. **Figure 10** shows the resulting eigenvalues plots.

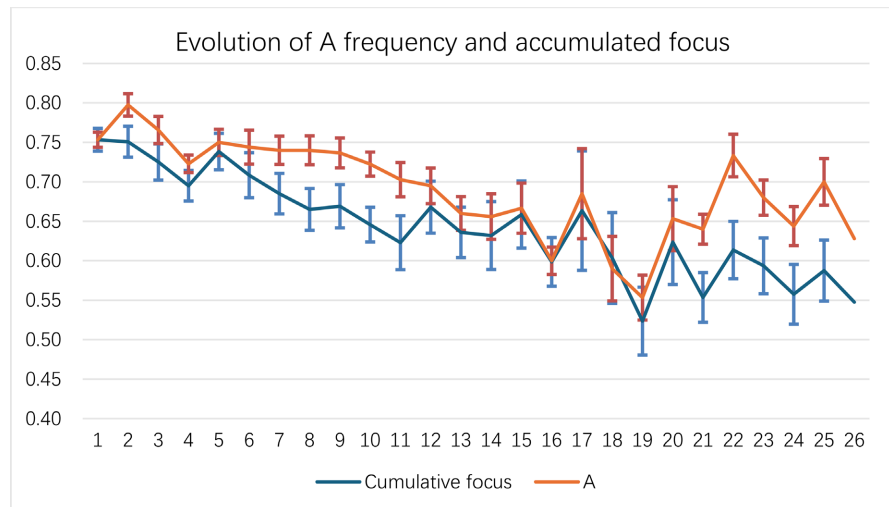


Figure 9. A's frequency compared to the accumulated focus frequencies added to the A frequencies in the first questionnaire, versus the session number.

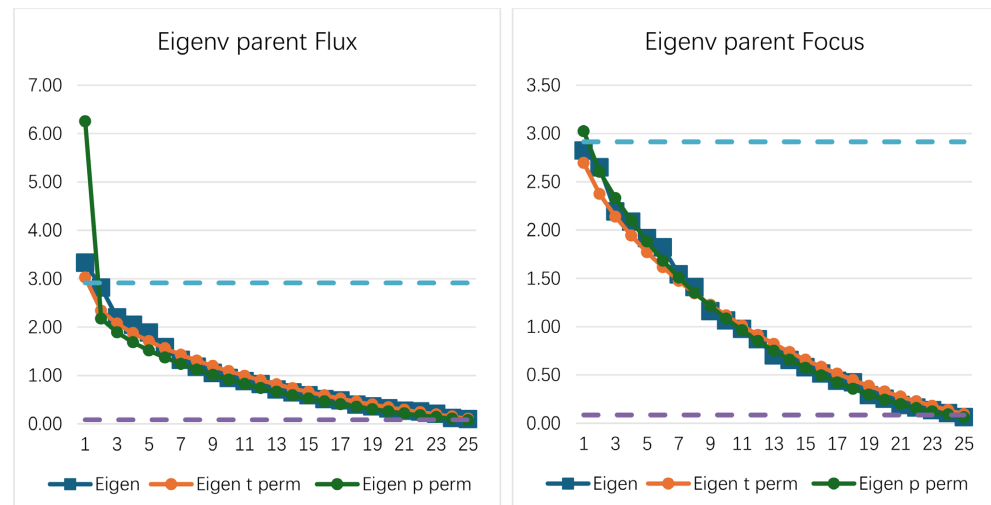


Figure 10. Spectral analysis of the correlation matrices for the flux and focus as defined in the text. The dashed purple and cyan lines indicate the lower and upper bounds predicted by the Marchenko-Pastur distribution for random correlation matrices of comparable dimensions. The red curve shows the mean eigenvalue spectrum obtained from Monte Carlo realizations in which session labels were permuted, thereby disrupting temporal alignment while preserving item-wise marginal distributions. The green curve corresponds to permutations of individuals within each session, preserving cross-sectional structure at each time point while eliminating subject-level continuity. In both cases, the displayed spectra are averaged over repeated realizations.

The dominant eigenvalue of the empirical flux spectrum ($\lambda = 3.33$) exceeds the Marchenko-Pastur limits and is significantly larger than the time-permuted results ($\lambda = 3.02 \pm 0.15$, $Z = 2.07$, $p = 0.039$). This confirms the importance of the time structure in the evolution of the group responses, whose flux appear again dominated by a single mode, suggesting a coordinated evolution across sessions. It is interesting to note that permuting the individuals within sessions yields an increased dominant mode ($\lambda = 6.25 \pm 0.37$), way beyond the other results.

The dominant eigenvalue of the empirical focus spectrum ($\lambda = 2.82$) is within the Marchenko-Pastur limits. The time-permutation Montecarlo dominant eigenvalue ($\lambda = 2.70 \pm 0.17$, $Z = 0.75$, $p = 0.45$) is not significantly different from the empirical data. The same is true for the permutation of the individuals in each session ($\lambda = 3.02 \pm 0.19$, $Z = 1.05$, $p = 0.29$). This negative result should not be overinterpreted in view of the amplified focus variance as explained before. Moreover, the requirement that at least four participants be present in both sessions reduces the effective sample size, making this quantity particularly sensitive to noise.

The Bernoulli random draws give us dominant modes for the focus ($\lambda = 3.17 \pm 0.24$, $Z = -1.46$, $p = 0.14$) and for the flux ($\lambda = 2.91 \pm 0.24$, $Z = -1.75$, $p = 0.08$), both not significantly different from the empirical data. These results do not provide evidence for a deviation from the Bernoulli null model in terms of the overall number of transitions or their net direction, suggesting that these aspects of the dynamics may be largely accounted for by binomial fluctuations around individual response tendencies.

3.4. Entropy Analysis

We now calculate the Bernoulli's entropy of the A' distribution in time:

$$h_{i,j}^{A,B} = -q_{i,j} \log_2(q_{i,j}) - (1 - q_{i,j}) (1 - \log_2(q_{i,j}))$$

We then compare it with our two null models permuting time labels and people. **Figure 11** shows the Bernoulli entropy of the A's frequencies of the empirical data and of the null models. The entropy of the empirical data fluctuates but does not show a discernible trend. The Page's L test is non significant.

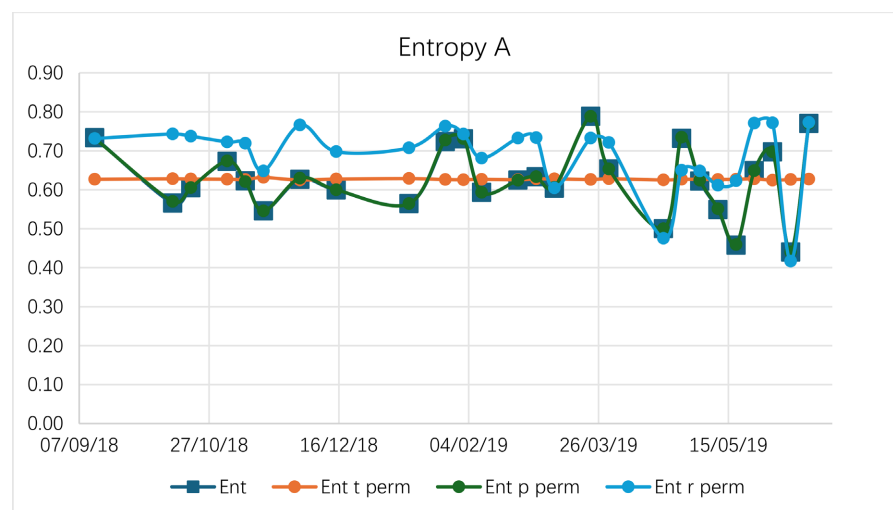


Figure 11. Bernoulli entropy of the A's probability versus time. The entropy of the empirical data (blue line) is numerically indistinguishable from the people permutation null model (green line). The purple line corresponds to the Bernoulli random-draw Monte Carlo. The time permutation entropy is the average entropy once the time structure is destroyed.

The values of the people permuted null models are numerically indistinguishable from the empirical data. The time-permuted null model is time-independent and provides the average entropy over time. Both these results are expected, and they do not provide any special information. The entropy of the empirical A distribution is systematically lower than that obtained under the Bernoulli null model, indicating that the observed dynamics are more constrained than expected from independent stochastic fluctuations based on individual response tendencies.

Then, we calculate, for each pair of successive sessions, empirical estimators of the transition probabilities between states A and B:

$$\begin{bmatrix} p_{i,j}^{A \rightarrow A} & p_{i,j}^{A \rightarrow B} \\ p_{i,j}^{B \rightarrow A} & p_{i,j}^{B \rightarrow B} \end{bmatrix} = \begin{bmatrix} P(A_{i,j} | A_{i,j-1}) & P(B_{i,j} | A_{i,j-1}) \\ P(A_{i,j} | B_{i,j-1}) & P(B_{i,j} | B_{i,j-1}) \end{bmatrix}$$

$$i \in \{1, \dots, 50\}, j \in \{1, \dots, 25\}$$

From this we can calculate Bernoulli's entropy for both binary processes:

$$A \rightarrow \{A, B\} \quad B \rightarrow \{A, B\}$$

$$h_{i,j}^{A \rightarrow A} = -p_{i,j}^{A \rightarrow A} \log_2(p_{i,j}^{A \rightarrow A}) - p_{i,j}^{A \rightarrow B} \log_2(p_{i,j}^{A \rightarrow B})$$

$$h_{i,j}^{B \rightarrow A} = -p_{i,j}^{B \rightarrow A} \log_2(p_{i,j}^{B \rightarrow A}) - p_{i,j}^{B \rightarrow B} \log_2(p_{i,j}^{B \rightarrow B})$$

$$i \in \{1, \dots, 50\}, j \in \{1, \dots, 25\}$$

Figure 12 shows the entropy of the $A \rightarrow B$ and $A \rightarrow B$ transition probability. Again, there is no discernible trend in the empirical data. The time-permuted null model provides a trivial result: the average entropy over time. The people-permuted null generally follows the empirical data, with a tendency for the $A \rightarrow B$ transition to be higher. The Bernoulli null model fluctuates similarly. We have not included it in the figure to avoid clutter.

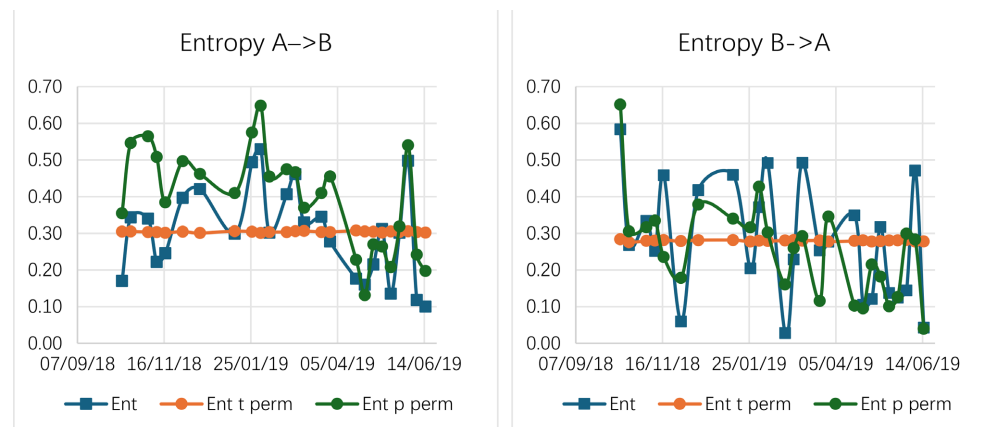


Figure 12. Bernoulli entropy of the $A \rightarrow B$ (left) and $B \rightarrow A$ (right) transition probabilities versus time. The entropy of the empirical data (blue line) is close to the people-permuted entropy, slightly larger for the $A \rightarrow B$ transitions. The time permutation entropy is the average entropy once the time structure is destroyed.

Lastly, we calculate the flux entropy for both the empirical data and the null

models. **Figure 13** shows the flux entropy. The time-permuted null model provides, as before, the average entropy once the time structure is destroyed. Interestingly, the people-permuted entropy is consistently higher than the empirical data.

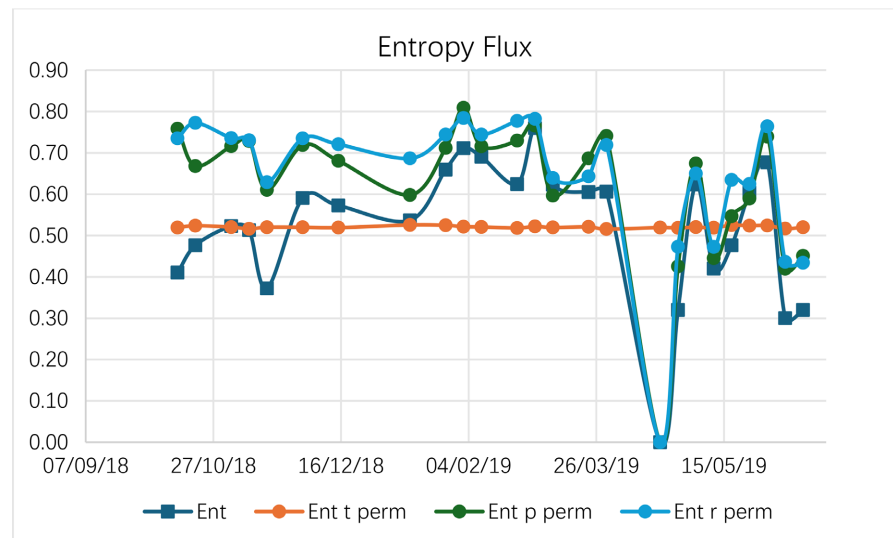


Figure 13. Bernoulli entropy of the flux versus time. The time permutation entropy is the average entropy once the time structure is destroyed. The entropy of the empirical data (blue line) is close to the people permuted entropy, and consistently lower. The purple line is the Bernoulli random null model, and it tends to be consistently higher than the empirical data entropy.

This result is consistent with the higher first eigenvalue of the people-permuted correlation matrix. Destroying the identity constraints increases the disorder at the microscopic level while enhancing the dominant mode of the correlation matrix. The process is, paradoxically, more coherent and more random.

The entropy obtained under the Bernoulli null model is consistently higher than that of the empirical data, indicating that the observed dynamics are more constrained than expected from independent stochastic fluctuations with the same average response probabilities.

To assess the potential influence of the LOCF correction for missing data, a sensitivity analysis was performed in which all LOCF-imputed values were replaced with independent Bernoulli draws across 2000 Monte Carlo realizations. This procedure represents a deliberately conservative perturbation of the original data, as the replacement values are generated independently of the observed temporal structure.

The resulting spectra were compared with those obtained using the LOCF procedure. No significant differences were observed in the leading eigenvalue for A→B transitions ($p = 0.85$), B→A transitions ($p = 0.56$), flux ($p = 0.26$), or focus ($p = 0.55$). A marginal difference was observed in the A distribution ($p = 0.08$), but it did not alter any of the study's qualitative conclusions.

These results indicate that the spectral properties reported here are robust with

respect to the treatment of missing values and are unlikely to be driven by the LOCF correction, which affected only a small fraction of the dataset.

4. Discussion

4.1. Theoretical Framework

The objective of this experiment is to measure the possible correlation between subconsciousness in a group setting. As said above, our assumption is that such correlations, if present at all, may be amplified by the group.

In this experiment, we cannot determine the nature of such correlations; however, we can at least assess whether our data are consistent with an interacting dynamical system by comparing its behavior with the average of null models generated via Monte Carlo simulations. As explained before, these models preserve the marginal distribution within sessions but destroy the time sequence across sessions or the participant identity within each block of 50 answers.

4.2. Percentage of A's Answers

Our analysis of the empirical data has found evidence of coordination among the A responses, which reduces the group's effective dimension with the introduction of a dominant mode in the correlation matrix. This finding is consistent with the fundamental tenet of group analysis that individuals in a group tend to behave as a coordinated, interacting ensemble.

This result motivates heuristic analogies to non-separable systems, which relies on the observation that group dynamics, as described by Bion's "basic assumptions," (Bion, 1961) are similar to individual dynamics, particularly in the crucial aspect of the mourning process by the individual following the loss of the group's ideal leader, inspired by an Oedipal constellation.

Participants in the group do not interact with one another while answering the questionnaire, which is completed individually and privately. Nevertheless, the responses display coordinated fluctuations and low-dimensional collective dynamics. The coordination, therefore, appears not to occur at the level of explicit interactions during the measurement itself, but at the level of the group's global state.

The evolution of A's answers is compatible with a low-dimensional coupled dynamic system. As **Figure 4** shows, the frequency of A choices exhibits a clear temporal evolution. The proportion of A responses decreases toward the middle of the training period and then rises again toward the initial value. This pattern may reflect the group's internal dynamics, although it could also be influenced by the entry of new participants, a feature inherent in the slow-open group structure.

It is interesting to note that the evolution of A frequencies also suggests the evolution of a Bionian small group. Group formation around a common sociocultural bias is very rapid. The bias is reinforced by the group situation in what we could identify as the "group illusion" phase. Follows the "disillusionment with the leader" and a partial drift away from the initial choices during a "fight or flight"

phase. Toward the end of the experience, the group mourns its approaching end, and we observe a “nostalgic” return to the initial group unity. Our data suggest this interpretation, but we are aware that our statistical analysis does not rule out alternative explanations.

The dimensional reduction is also observed in the time-permuted Montecarlo results. Because the session permutation procedure preserves the distribution of each questionnaire item but destroys temporal alignment across items, the observed dimensional reduction cannot be attributed to a static latent factor structure (such as those used to validate questionnaires) but instead reflects synchronized temporal evolution across items.

4.3. Analysis of the Transitions of the Answers

The evolution of the $A \rightarrow B$ and $B \rightarrow A$ transition frequencies does not show a particular trend and its correlation matrix is compatible with random fluctuations. The same is true for the time-permuted Montecarlo. Conversely, individual permutation within each block of 50 answers significantly increases the dominant mode.

The focus does not show a particular trend, and the null model correlation matrices are very similar to the empirical data one. Still, as we have seen, the A answers present a discernible trend. These two facts are not in contradiction. The focus presents strong random fluctuations, while its integral versus time is consistent with the A’s behavior. The “random noise” of the focus appears to dwarf the “signal,” and our statistical tests are dominated by it. This is easy to understand if we consider that the focus is the difference between two values, while its variance is the sum of the variances of the two terms.

In the case of flux, on the contrary, we observe a further enhancement of the dominant mode. This reinforces the evidence of a coordinated increase in activity without drift (e.g., non-random alignment of item-wise deviations and synchrony across groups in calendar time). This observation supports the interpretation of a coupled collective process. This does not demonstrate entanglement in the physical sense, but it is compatible with it.

If we want to pursue our heuristic Bionian analogy, the flux increases toward the middle of the experience, when the group should go through the disillusion and fight-or-flight phases.

In this framework, deviations of the empirical eigenvalue spectrum from the individual permutation null expectations must be interpreted carefully. In particular, the observation that randomized data can exhibit larger leading eigenvalues does not indicate weaker structure in the empirical data; rather, it suggests the presence of organizing constraints that limit the magnitude of pairwise correlations. In other words, the empirical system appears to support coordinated behavior while simultaneously limiting the amplification of collective modes, thereby compressing the eigenvalue spectrum relative to the null models. But the result may also indicate the importance of persisting in individual choices across ses-

sions. The comparison with individually permuted data indicates that the empirical system is not maximally coherent; rather, collective alignment is limited by persistent individual structure that is removed by permutation.

In the case of flux, in particular, the sum of transitions amplifies the collective fluctuations. The individual permutation Montecarlo seems to remove constraints due to individuality and boost common variance alignment, increasing the observed coherence. The Bernoulli null Montecarlo is consistent with these observations, indicating a system that is more constrained than a purely random one with the same average values.

Another possible interpretation of the dominant mode enhancement in the individual permuted Montecarlo could bring to light a Bionian superposition of a work and base groups. The comparison between real and individually-permuted data suggests that the empirical system lies between two extremes: a purely individual-driven regime and a fully homogenized collective regime. The persistence of a dominant eigenmode in the real data, albeit weaker than in the homogenized case, is compatible with the presence of a partially structured group-level dynamic, which is not reducible to independent individual fluctuations.

4.4. Analysis of Entropy of the Answers

The entropy analysis seems to support these results. We have essentially three regimes. The time-permuted regime is unstructured with a flat entropy and low eigenvalues of the correlation matrix. The individually permuted data show maximal mixing, maximal eigenvalues and the limit of the coherence of individual answers.

The apparent contradiction between an increase in entropy and an enhancement of the dominant mode is only superficial. Permuting individuals disrupts temporal persistence at the individual level, making responses less predictable across sessions and thereby increasing local uncertainty.

An increase in the leading eigenvalue of the correlation matrix does not imply that the data become simpler or more ordered at the individual level. Rather, it indicates the emergence of a strong common direction: variables fluctuate more coherently along a shared mode, reflecting increased synchronization at the global level.

Disorder at the individual level can therefore remain high while becoming strongly structured across variables. In our case, removing individual identity and persistence weakens idiosyncratic trajectories but enhances a mean-field-like macroscopic organization.

Permuted individuals no longer persist in their choices, yet their variations remain aligned. Thus, permutation attenuates independent fluctuations while preserving—and even amplifying—collective coordination.

The empirical data sit in between these two limits, with a clear time structure and intermediate eigenvalues and entropy. Structure in the real system comes from constraints, not from maximal coherence. These constraints seem to come

from the persistence of the individual decisions. Once these constraints are removed, there is more randomness at the individual level but also more coherence at the group level. From a Bionian psychoanalytic point of view, this could be cautiously interpreted as the emergence of the base group trend, once individual trajectories are removed. The Bernoulli null model is consistent with these observations.

We want to emphasize that, as we said before, the presence of a dominant temporal mode in the evolution of the answers and their variations does not, in itself, constitute proof of coordination between the participants' unconscious, but it is certainly compatible with such a hypothesis. This effect could also be explained by the persistence of the initial sociocultural bias toward one picture in each pair, which carries over across sessions.

4.5. Philosophical Considerations

We present here some unverified philosophical considerations on the nature of the correlation between individuals in a group. The Swiss psychoanalyst Carl Jung did not focus his attention on the “collective,” which he considered merely the starting point for the individuation process. He has nevertheless elaborated one of the most suggestive metaphors for the “collective soul.” Jung (Jung & McGuire, 1925) describes the individual psyche as the ultimate element of a layered unconscious, in which each successive stratum is shared by a broader community of people and, for the most profound layers, of living beings. Jung's “collective unconscious” (Jung, 1959) is where the worlds of reality and the soul meet. Their connection may appear “acausal,” but Jung (Jung, 1952, 1960) believes that it is governed by the unfathomable logic of the collective unconscious.

Jung calls the manifestation (“emergence”) of these relations to our senses “synchronicity” (Jung, 1952), intended as the perception of a meaningful correlation between an inner condition—feeling or thought—and an external event with no apparent causal relation between them.

When the physicist Wolfgang Pauli, one of the most brilliant minds of the 20th century, initiated his analysis with Jung, they felt there was an intriguing similarity between synchronicity and the recently discovered phenomenon of quantum entanglement, a cornerstone of quantum physics. (Aspect et al., 1982; Bell, 1964, 1966; Bohr, 1935; Einstein et al., 1935; Richens et al., 2017; Schrödinger, 1935, 1936). This observation marked the beginning of the intellectual collaboration between Jung and Pauli, who sought to ground both the description of the material world and that of the soul in the same basic principles (Jung et al., 2001).

Inspired by this hypothesis, other authors have explored the behavior of the human psyche in light of the laws of Quantum Mechanics, with particular attention to the relationship between synchronicity and quantum entanglement. Some authors have posited a universal quantum field of (un)consciousness (Baaquie & Martin, 2005; Orlov, 1982) linking to all living creatures. Other authors have argued that when two individuals interact, they temporarily lose their individuality

and form a connected system. (Galli Carminati et al., 2017; Galli Carminati & Martin, 2008; Martin & Carminati, 2009, Martin et al., 2009, 2010, 2013). This model can be extended to a whole group (Grinberg-Zylberbaum et al., 1994; Martin & Carminati, 2009), where entanglement among the different unconsciouss gives rise to a single entity with distinct collective behavior (Marshall, 1989). Several authors have contributed to this new field of study collectively known as psychophysics (Beck & Eccles, 1992; Conte et al., 2003; Freeman & Vitiello, 2016; Hameroff & Penrose, 1996; Penrose, 1989, 1994; Pitkänen, 2012; Sabbadini & Vitiello, 2019; Vitiello, 2003; Zurek, 1981)

Other authors have proposed that quantum processes could play a fundamental role in consciousness and cognition, including Penrose and Hameroff's Orch-OR theory (Hameroff & Penrose, 1996), Stapp's quantum mind-brain interaction model (Stapp, 1982), and earlier proposals linking consciousness to quantum measurement (Eccles, 1994; Hameroff & Penrose, 1996; Penrose, 1989, 1994; Stapp, 1999; von Neumann, 1955; Wigner, 1961). It is important, however, to note that most neuroscientists and physicists consider these theories speculative, largely because maintaining coherent quantum states in the brain's "warm, wet and noisy" environment appears extremely difficult (Koch & Hepp, 2006; Tegmark, 2000).

This experiment measures the possible correlation between subconsciousness in a group setting. In a suggestive analogy to quantum mechanics, we can say that measurement is also critical in psychophysics. Here, in the footsteps of Pauli and Jung, a useful intellectual analogy can be drawn with quantum entanglement. In quantum mechanics, correlations between subsystems may render the global system inseparable: once prepared in an entangled state, it cannot be described as the sum of independent components. The correlations observed in measurements do not necessarily reflect direct interactions at the point of observation, but rather the structure of the shared state.

In our case, the epistemological problem is due not only to the nature of the unconscious, which escapes consciousness, but also to the fact that the "detector" is the mind's activity, which is deeply dependent on the unconscious processes.

In quantum physics, a microscopic process is "amplified" by the "observer" to the macroscopic level, enabling measurement. Thus, only after amplification can we observe a microscopic quantum process as a physical phenomenon through measurement. However, the irreversibility of such an act remains a matter of debate.

Our results do not allow us to assert the presence and effects of quantum-like coherence terms (e.g., off-diagonal density-matrix elements). However, we can at least assess whether our data are consistent with an interacting dynamical system by comparing its behavior with the average of null models generated via Monte Carlo simulations. We can say that the observed coordinated temporal evolution is not incompatible with such a framework. However, the present data do not permit privileging this interpretation over that of a classical interacting system. The

underlying mechanisms responsible for the observed coordination between individuals remain unresolved and warrant further investigation.

5. Conclusion

In this study, we considered only the parent slow-open group. The comparison with the adolescent groups will be the subject of a subsequent publication.

The data reveal a low-dimensional, temporally coordinated evolution of responses that cannot be accounted for by independent fluctuations. Comparison with null models indicates that temporal organization generates a genuine collective mode, while persistent individual structure limits both mixing and the amplification of this mode.

A dominant common mode coexists with individual trajectories. When these trajectories are disrupted through individual-permuted Monte Carlo, the common mode is enhanced. Entropy analysis is consistent with this observation: mixing increases local unpredictability at the individual level while preserving—and even strengthening—the collective structure.

The system therefore exhibits a clear temporal organization, compatible with an interacting process in which individual variability unfolds within a coordinated group-level dynamic.

This pattern is consistent with interpretations in terms of group-level dynamics, such as those described in Bionian frameworks, where a shared underlying process coexists with individual expressions. However, such interpretations remain heuristic and are not uniquely determined by the data.

Further work, including more refined models and experimental designs, will be required to discriminate between alternative explanations and to characterize the nature of the underlying interactions.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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