Scientific Research Publishing

Psychology, 2022, 13, 1573-1599
https://www.scirp.org/journal/psych
ISSN Online: 2152-7199
ISSN Print: 2152-7180

# Dialectical Behavior Group Therapy for Adolescents and Parents: Analysis of Answer Entropy

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**How to cite this paper:** Fernandez-Rivas, A., Sesma-Pardo, E., Kerexeta, I., Diaz-Cosgaya, A., Vivanco, E., Carminati, F., Torres, M. A. G., Fouassier, C., Martin, F., Demongeot, J., & Carminati, G. G. (2022). Dialectical Behavior Group Therapy for Adolescents and Parents: Analysis of Answer Entropy. *Psychology*, *13*, 1573-1599.
https://doi.org/10.4236/psych.2022.1311099

**Received:** September 9, 2022
**Accepted:** October 17, 2022
**Published:** October 20, 2022

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## Abstract

**Introduction:** The work's purpose is to study the group behavior of the members of six therapeutic groups, two closed and four slow-open, involved in a Dialectical Behavior Therapy (DBT) class. We studied three groups of teenagers and three of their parents or legal guardians. We confronted the groups' responses to an "absurd questionnaire" submitted during the training, and we concentrated on the entropy of the response. **Methods:** The research method consists of a questionnaire administered to training attendees. Participants chose one picture in each one of 50 couples ("absurd questionnaire"). In this work, we could propose a questionnaire to each trainee before the first meeting of the groups. We studied the longitudinal evolution of entropy, and we also compared the six groups according to their first picture choices and their evolution, the changes in the choices, the number of changes (flux), and the divergence or convergence toward the initial answer (focus). We have also analyzed the frequency of entropy variation via the Fourier transform. **Results:** We find the maximum statistical difference between parents' and adolescents' closed groups. The entropy trend is steeper in the adolescent closed group. The entropy evolution depends more on the age group (parents or adolescents) in closed and slow-open groups than on the setting. We found an increase in entropy from the beginning to the end of the training in all the groups. **Conclusions**: The clear outcome of this study is the

augmentation in entropy in all the groups regardless of the settings (closed or slow-open) and possibly a similar entropy's dominant oscillation frequency, that is, the number of complete cycles in the training interval, regardless of the type of group and the training duration.

## Keywords

Dialectical Behavior Therapy (DBT), Group Dynamics in Young and Parents, Slow-Open Group Work, Group Analysis, Psychophysics, Unconscious Entanglement, Pauli-Jung Hypothesis, Quantum Amplification, Bion's Basic Assumptions, Synchronicity, Quantum Entanglement

## 1. Introduction

This study investigates the collective behavior of the participants in six therapy groups, two closed and four slow-open, as part of Dialectical Behavior Therapy (DBT) skills teaching at the Basurto University Hospital Psychiatric Service (Bilbao, Spain). Three of the groups were composed of teenagers, three of some of their respective parents or legal guardians.

Our reason for this work is to explore whether the supposed entanglement of unconsciouses in a group experience is observable in an "objective" and quantifiable way. We suppose that the group setting "amplifies" intra-unconscious interactions making them "macroscopically" manifest. Given the central importance of our unconscious in all normal and pathological behaviors, factual evidence for this phenomenon could be highly relevant both theoretically and, possibly, therapeutically.

This work, the latest in a series of studies on the subject (Fernandez-Rivas et al., 2020, 2021a, 2021b; Trojaola-Zapirain et al., 2014, 2015, 2016, 2019), analyzes the evolution of the participants' absurd questionary responses by focusing on the entropy of the answers. As in our previous works, we make the hypothesis that the group setting "amplifies" the unconscious interaction making it "measurable" at the "macroscopic" level, in this case, via the evolution of the answers' entropy. In physics, entropy characterizes the "disorder" of a system, and it is maximum when the system is at equilibrium.

As we will see later, we observe a different trend in the entropy evolution between closed and slow-open groups. Even if the members of the closed groups interact with families, friends, and society, we detect differences between these groups and the slow-open ones, where participants enter and leave the groups during the training. This result suggests that we have amplified the interaction between unconsciouses and can observe a difference between the intrinsic order of "closed" and "open" systems. We can suppose that the different settings and attendance in the two kinds of groups cause a difference in their "Bionian" nature, which is what we measured with our questionnaire.

We apply a discrete Fourier transform to characterize the entropy variation

during the training. The amplitudes of the Fourier coefficients indicate the importance of a given frequency in describing the fluctuations of the measured entropy. We performed this analysis with and without the initial questionnaire administered before the beginning of the training.

In this work, we administered a version of the questionnaire to the participants before forming the groups. We then analyzed the differences in entropy in time and between the six groups, considering their initial picture choices and how these evolved in time.

We have explained the rationale for this research in the mentioned publications (Fernandez-Rivas et al., 2020, 2021a, 2021b; Trojaola-Zapirain et al., 2014, 2015, 2016, 2019), so a summary will suffice here.

Several authors (Linehan, 1993a, 1993b, 2015; Miller et al., 2006) have identified Dialectical Behavioral Therapy as an effective transdiagnostic treatment for adults and teenagers affected by impulsivity and emotional dysregulation. The Basurto University Hospital Psychiatric Service (Bilbao, Spain) has implemented a DBT therapeutic program with all its components, including adolescent and parent skill training groups.

The prolific relation between C.G. Jung and W. Pauli led to the hypothesis that synchronicity, discovered by Jung (Jung, 1952), was the psychological expression of quantum entanglement (Jung et al., 2001). According to Jung, synchronicity is an emotional connection between a feeling or thought and an objective event with no detectable causal relationship. Jung did not explicitly study group behavior since the individuation process, which he considers the ultimate process of moral evolution, demands that the individual emerges from the "collective" to find his true self. Moreover, Jung's hypothesis of the collective unconscious allows us to analyze and understand the "collective soul" (Jung, 1959) as the *locus* where reality connects with the soul (Jung, 1952, 1960).

Wilfrid Bion (Bion, 1961) proposed the first psychological theory of the groups with his "basic assumptions," i.e., universal laws regulating the working of all human gatherings. Other authors completed this theoretical framework with the description of the complex interaction network inside and outside the group (Foulkes, 1964; Vergopoulos, 1983) and even postulated that the individual psyche has a "group" nature (Kaës, 2010). Bion's principal teaching is that we should not see the members of a group moved by the "basic assumptions" merely as individuals but also as expressing the group's psychical entity (Bion, 1961). This behavior is evocative of what happens at the microscopic level when quantum particles interact and form a general "entangled" state. In this state, the behavior of each single particle can only be observed and understood as an expression of the global state of the system (Aspect et al., 1982; Bell, 1964, 1966; Bohr, 1935; Einstein et al., 1935; Richens et al., 2017; Schrödinger, 1935, 1936).

According to quantum mechanics, we can observe microscopic processes via their interaction with macroscopic objects that play the role of detectors. This process is what we indicate with "quantum amplification." Jung also uses the

term amplification (Jung & Hull, 1911) as the process of expansion of the meaning of a dreamed image thanks to the patient's free associations and the correspondence between the image and similar symbols in socio-cultural and historical contexts. Jung (Jung, 1962) says that the analyst can interpret the dream's content only thanks to this double process (personal and social).

The foundational hypothesis of psychophysics is that it is possible to model consciousness as a universal quantum field (Baaquie & Martin, 2005; Conte et al., 2003; Orlov, 1982). Other scholars have studied the link between mind and matter in the light of a monistic theory describing both behaviors (Freeman & Vitiello, 2016; Pitkänen, 2010). Several works have searched for the location and mechanisms of brain quantum phenomena (Beck & Eccles, 1992; Galli Carminati et al., 2017; Grinberg-Zylberbaum et al., 1994; Hameroff & Penrose, 1996; Sabbadini & Vitiello, 2019). Several works have discussed Quantum Information Theory as a possible formalism to describe mental activities (Cerf & Adami, 1998; Martin et al., 2009, 2013; Martin & Galli Carminati, 2009). Other contributions, more general in nature, tend to reconsider the epistemological bases of quantum mechanics in the context of its supposed ability to explain also mental activity (Marshall, 1989; Martin & Galli Carminati, 2009; Penrose, 1989; Vitiello, 2003; Zurek, 1981).

Starting from this interesting analogy, some of the authors have considered studying the human group activity as a multi-body entangled system (Galli Carminati & Carminati, 2006; Galli Carminati & Martin, 2008; Martin, Carminati, & Galli Carminati, 2009; Martin, Carminati, & Galli Carminati, 2010; Martin, Carminati, & Galli Carminati, 2013). This hypothesis has led to the formulation of the "absurd experiment" that is the subject of this paper and that has already been performed on different psychodynamics groups (Fernandez-Rivas et al., 2020, 2021a, 2021b; Trojaola-Zapirain et al., 2014, 2015, 2016, 2019).

## 2. Materials and Methods

### 2.1. Participants

The groups considered in this paper are the same as in (Fernandez-Rivas et al., 2020, 2021a, 2021b; and we will briefly recall here the experimental settings.

We have included in this study two slow-open adolescent DBT groups and one closed adolescent group (hereon Young). All of them followed a 16 2-hour skill training session weekly. In the slow-open groups, participants are allowed to leave and join the groups during the training.

In addition, the groups corresponding to the parents or legal guardians of the respective adolescents were included (hereon Parents). They consisted of two slow-open groups and a closed group of 10 1.5-hour skill training sessions weekly. In the case of the slow-open groups, the parents or legal guardians could join and leave the group during the training.

The adolescent groups were contemporary to the parent groups (on different weekdays).

We present in Table 1 the participants' demographical data. The adolescents in these groups suffered from behavioral problems, impulse-control disorders, or emotional dysregulation. No other specific selection criteria were applied.

## 2.2. Procedure

DBT skill training focuses on mindfulness, distress tolerance, emotion regulation, effective interpersonal communication, and choosing the middle path. Two therapists supervise each group.

Before the training, participants (adolescents and parents) sat for an evaluation and information interview on the group's organization and the research, in which they filled out the informed consent and the questionnaire number "zero" (with one exception). Since we performed this interview at different times, in the following, we arbitrarily set its time one month before the first group. We also collected sociodemographic data on adolescents (see Table 1).

We have already described the experimental procedure in previous publications (Fernandez-Rivas et al., 2020, 2021a, 2021b; Trojaola-Zapirain et al., 2014, 2015, 2016, 2019). As a reminder, we recall that the questionnaires had 50 pairs of figures, randomly reshuffled at each submission to avoid memory bias. We asked participants to select one from each pair of pictures in three minutes. In addition, we have chosen images to reduce the socio-cultural bias potentially introduced by a word test (Zanello et al., 2004). Figure 1 shows an example of a questionnaire page with fictitious picture selections.

**Table 1.** Demographic and social composition of the six groups participating in this study.

| | Adol GC | Adol G1 | Adol G2 | Parents GC | Parents G1 | Parents G2 |
|---|---|---|---|---|---|---|
| Total | 7 | 21 | 16 | 5 | 25 | 19 |
| Female | 7 (100.0%) | 14 (66.7%) | 14 (87.5%) | 3 (60.0%) | 18 (72%) | 11 (57.9%) |
| Average age | 16.7 | 15.6 | 16.4 | | | |
| 1Q-3Q | 16.5 - 17.0 | 14.9 - 16.5 | 15.3 - 17.4 | | | |
| Biological Family | | 8 | 7 | | | |
| Adoptive Family | 2 | 1 | 2 | | | |
| Single Parent | 5 | 10 | 6 | | | |
| Other living situations | | 2 | 1 | | | |
| Undergraduate education | 3 | 17 | 9 | | | |
| Graduate education | 2 | 4 | 6 | | | |
| Apprenticeship | 2 | | | | | |
| Postgraduate education | | | 1 | | | |

In what follows, PGC is the parent closed group, PG1 is the first parent slow-open group, PG2 is the second parent slow-open group, YGC is the adolescent closed group, YG1 is the first adolescent slow-open group, and YG2 is the second adolescent slow-open group. The training duration was 11 sessions for PGC, 43 sessions for PG1, 27 for PG2, 11 for YGC, 43 for YG1, and 31 for YG2.

As we can see in Figure 2, Figure 3, and Figure 4, participation was not very regular, particularly for the adolescent groups after the fifth session.

## 3. Data Analysis

For each picture pair, we label with A ($A_i$, $i = 1, 50$) the most often chosen in the Qst0 submitted before the beginning of the training, and we label the least often chosen picture of the pair as B ($B_i$, $i = 1, 50$).

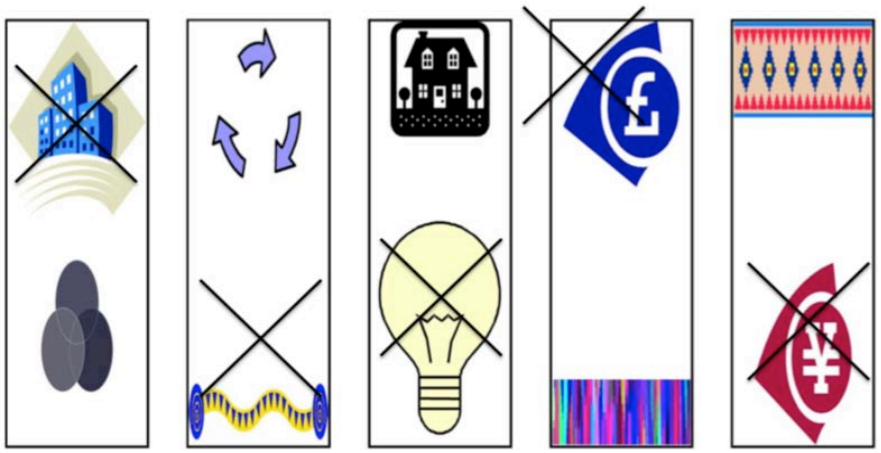


Figure 1. Example of a page of the questionnaire with fictitious answers.

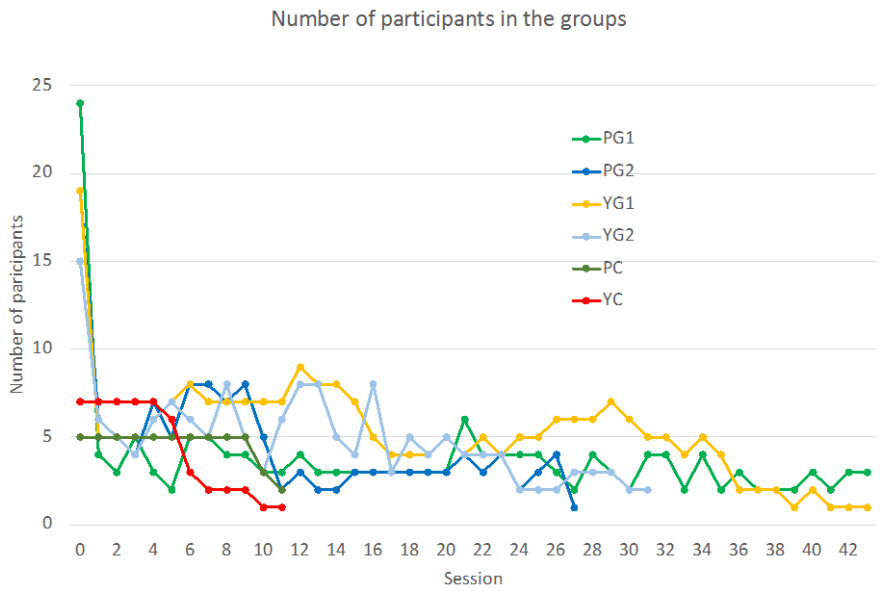



Figure 2. Number of participants in the different sessions.

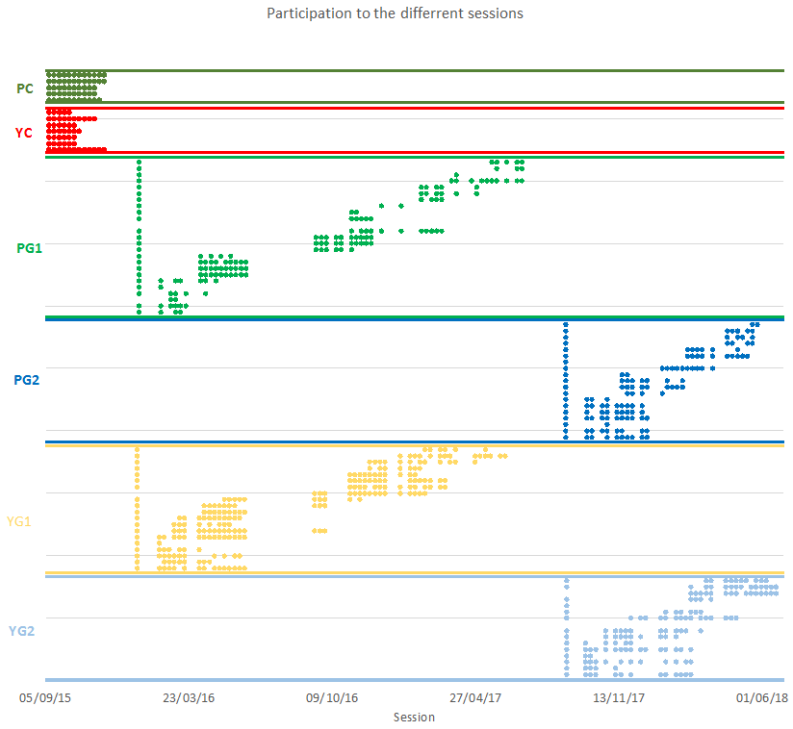



**Figure 3.** Participation of the trainees at the different sessions.

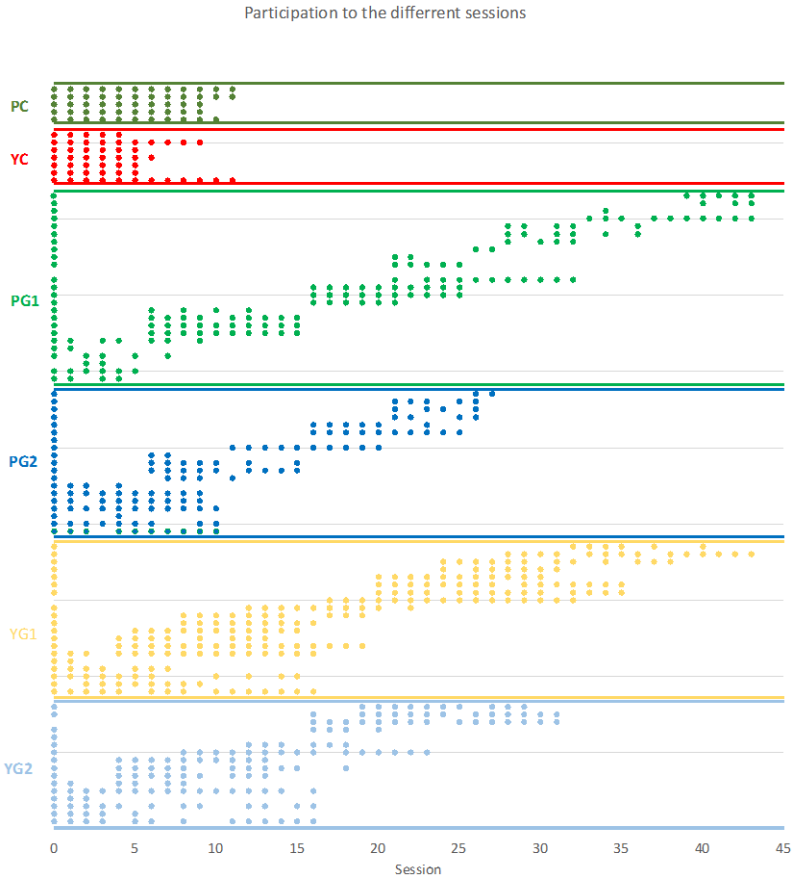



**Figure 4.** Evolution of the attendance to the training versus time.

We report frequency tables for each couple of images and each session for the six groups. We study the evolution of the whole group rather than that of the single participant's changes of choices. Therefore, we have analyzed the modification in time of the A's picture frequencies and not the individual participant's choice.

For the open groups, we did not consider it appropriate to correct completely missing data. Since many participants abandoned the closed groups toward the end, we did the same for the closed groups. However, we used LOCF (Last Observation Carry Forward, (Hamer & Simpson, 2009)) to fill in incorrect or missing (forgotten) answers in existing questionnaires. In case of a missing or incorrect answer, we took that of the preceding session or the one before it, if also this was missing, and so on. We selected the picture randomly if the faulty answer was in Qst0. **Table 2** shows the number of corrections.

We performed the study after the approval of the Basurto University Hospital Ethics Committee (Bilbao, Spain) in adherence to the Helsinki Declaration for research with human subjects. All participants gave written informed consent after receiving oral and written information about the experiment, and specifically for adolescents, both the participant and their parent or legal tutor gave their informed consent. All participants' identities were coded to become completely anonymous, including to those analyzing the data.

We concentrated our study on the frequencies of the A's answers. Given that this is a binary process, we can calculate its entropy via Bernoulli's formula (MacKay, 2003):

$$H_b(p) = -p\log_2(p) - (1-p)\log_2(1-p)$$

where $p$ is the probability of having a given number of A, which is given by the binomial distribution:

$$p(k;n,P) = \binom{n}{k} p^k (1-p)^{n-k}$$

We consider the *a priori* probability of choosing one of the two pictures to be 50%. Next, we built tables of entropy for each of the 50 pictures and each of the sessions. We have then made four analyses.

**Table 2.** Data corrected resulting from the LOCF procedure.

| Group | Total valid answers | Answers corrected with LOCF | % |
|---|---|---|---|
| PGC | 2750 | 357 | 13.0% |
| PG1 | 8148 | 101 | 1.2% |
| PG2 | 6406 | 95 | 1.5% |
| YGC | 2600 | 252 | 9.7% |
| YG1 | 11,131 | 69 | 0.6% |
| YG2 | 7037 | 63 | 0.9% |

1) A longitudinal analysis for each of the groups. First, we perform a Friedman test (Hollander & Wolfe, 1999), and if we find that it is significant ($p < 0.05$), we perform a post-hoc test for each pair of successive sessions (Conover, 1999; Conover & Iman, 1979) with the Holm correction (Holm, 1979).

2) A comparison for each pair of groups session by session with the Wilcoxon rank sum test (equivalent to the Mann-Whitney test) (Hollander & Wolfe, 1999).

3) Since the number of participants fluctuated with the session (primarily diminishing), we studied the relation between the average entropy of the 50 answers of each session and the number of participants.

4) We performed a Fourier analysis (Terras, 2005) of the fluctuations of the average entropy with time. First, we detrended the entropy as a function of time by subtracting the linear trend as a function of time from the entropy value. This operation provided us with a function of time with 0 average without altering its time-dependent fluctuations.

We will describe the results in the next section.

## 4. Results

To set the context of our analysis, we show the evolution of the average percentage of A's choices with time (**Figure 5**) and their evolution with the number of sessions (**Figure 6**). We remember that we call A pictures the ones most chosen in each pair in Qst0, submitted to participants before the group's creation.

We notice that the A percentage varies between the groups between Qst0 and the last session. In particular, the percentage of A's choices decreases slightly for the parents of the closed group but increases for the parents of the two slow-open groups. In addition, the adolescents present a different trend with a decrease in the A percentage compared to Qst0.

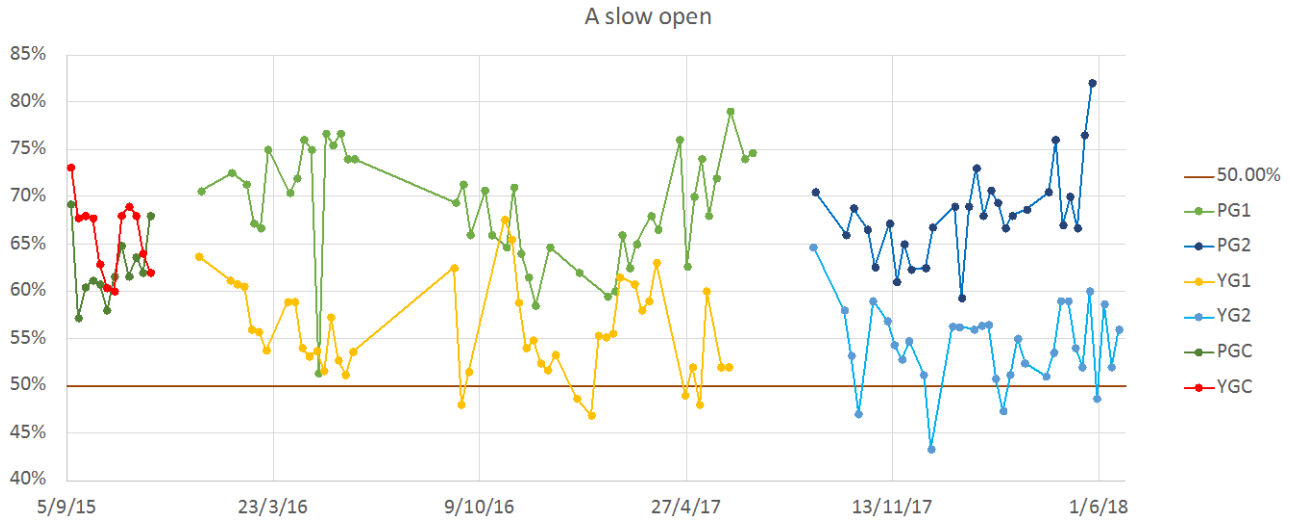



**Figure 5.** Evolution of the average percentage of A's choice versus time. YG1 and YG2 are the two slow-open adolescent groups, PG1 and PG2 are the two slow-open parent groups, and YGC and PGC are the closed adolescents and parent groups.

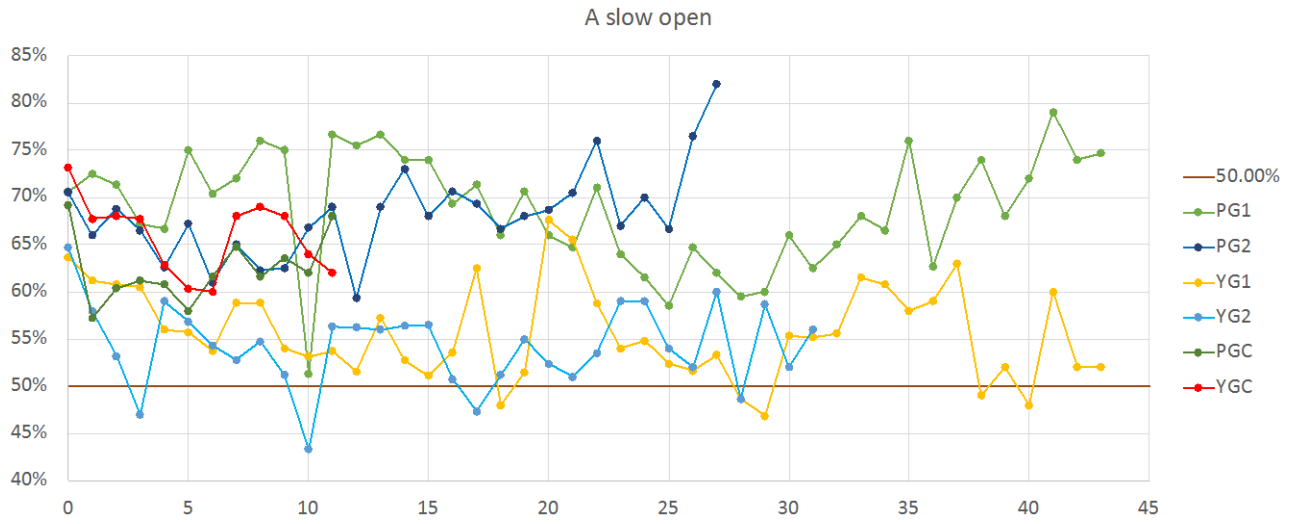



**Figure 6.** Evolution of the average percentage of A's choice session number. YG1 and YG2 are the two slow-open adolescent groups, PG1 and PG2 are the two slow-open parent groups, and YGC and PGC are the closed adolescents and parent groups.

**Table 3.** Evolution of the percentage of the A's choice from the Qst0 to the final session for each group.

| *Group* | Qst0 A % | Final A % | Δ |
|---|---|---|---|
| *PG1* | 70.6% | 74.7% | +4.1% |
| *PG2* | 70.5% | 82.0% | +11.5% |
| *PGC* | 69.2% | 68.0% | −1.2% |
| *YG1* | 63.7% | 52.0% | −11.7% |
| *YG2* | 64.7% | 56.0% | −8.75% |
| *YGC* | 73.1% | 62.0% | −11.1% |

The attendance in the closed group of adolescents was less regular after the fifth session, and in other groups, the participation was somewhat uneven, being also here the attendance less regular for the adolescents.

In Figure 7 we present the evolution of the average entropy of A's choice versus time, and in Figure 8 the evolution versus the session number.

We notice an increase in entropy in all groups, with a steeper trend for the adolescents' closed group. Furthermore, for all groups, the entropy increases between Qst0 and the end of the group therapy (see Table 3).

### 4.1. Longitudinal Entropy Analysis

We present here the longitudinal analysis for each of the groups. First, we perform a Friedman test, and if we find it significant ($p < 0.05$), we perform a post-hoc test for each pair of successive sessions with the Holm correction. All of Friedman's tests are statistically significant. Finally, we report the results of the post-hoc in Table 4.

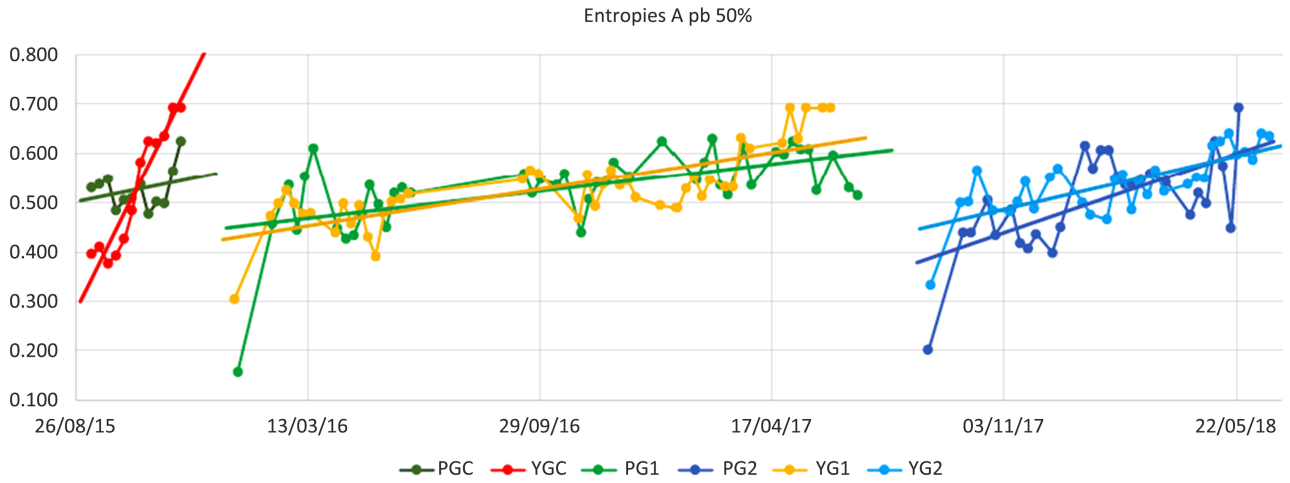



**Figure 7.** Evolution of the average entropy of A's choice versus time. YG1 and YG2 are the two slow-open adolescent groups, PG1 and PG2 are the two slow-open parent groups, and YGC and PGC are the closed adolescents and parent groups.

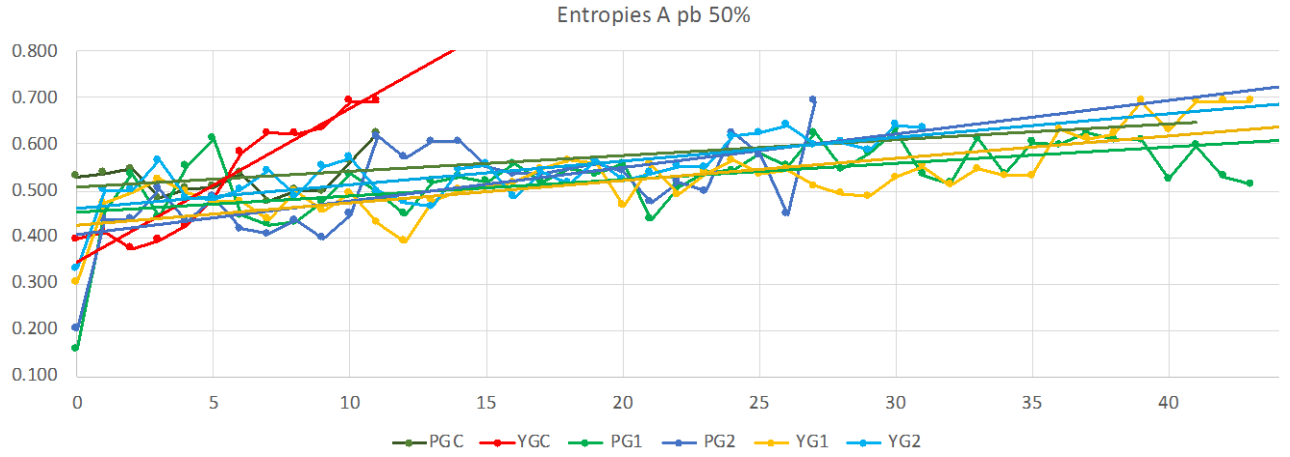



**Figure 8.** Evolution of the average entropy of A's choice session number. YG1 and YG2 are the two slow-open adolescent groups, PG1 and PG2 are the two slow-open parent groups, and YGC and PGC are the closed adolescents and parent groups.

The significant differences are few and are present between the Qst0 in parent groups 1 and 2 and the adolescents of group 1. The closed young group, which also has a pronounced decrease in entropy, does not show statistically significant differences from one session to the other.

The parents' and the adolescents' slow-open groups show statistically significant differences between Qst0 and the questionnaire passed in the first therapy session. There is no other collective behavior in the different groups.

### 4.2. Comparisons between Groups

Table 5 presents the results of the comparison of the same session for each couple of groups. In this table, we report the value of the Wilcoxon rank sum test (equivalent to the Mann-Whitney test) between groups for the percentage of A's for the 50 questions. The values marked in red have a value of $p < 0.05$ and are statistically significant.

**Table 4.** Results of the comparisons of the entropy of the 50 answers between one session and the next. As explained in the text, we report the values of $p$ for the post-hoc test for each pair of successive sessions with the Holm correction. The Friedmann tests for the matrix of the 50 values of entropy vs. the sessions are always statistically significant.

| Transition | PG1 | PG2 | PGC | YG1 | YG2 | YGC | Transition | PG1 | PG2 | PGC | YG1 | YG2 | YGC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A00 - A01 | 0.00 | 0.00 | 1.00 | 0.01 | 0.06 | 1.00 | A22 - A23 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| A01 - A02 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | A23 - A24 | 1.00 | 0.00 | | 1.00 | 1.00 | |
| A02 - A03 | 0.43 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | A24 - A25 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| A03 - A04 | 0.03 | 1.00 | 1.00 | 1.00 | 0.05 | 1.00 | A25 - A26 | 1.00 | 0.01 | | 1.00 | 1.00 | |
| A04 - A05 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | A26 - A27 | 1.00 | 0.00 | | 1.00 | 1.00 | |
| A05 - A06 | 0.00 | 0.96 | 1.00 | 1.00 | 1.00 | 0.07 | A27 - A28 | 0.23 | | | 1.00 | 1.00 | |
| A06 - A07 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | A28 - A29 | 1.00 | | | 1.00 | 1.00 | |
| A07 - A08 | 1.00 | 1.00 | 1.00 | 1.00 | 0.57 | 1.00 | A29 - A30 | 1.00 | | | 1.00 | 1.00 | |
| A08 - A09 | 1.00 | 1.00 | 1.00 | 1.00 | 0.12 | 1.00 | A30 - A31 | 0.00 | | | 1.00 | 1.00 | |
| A09 - A10 | 1.00 | 1.00 | 0.01 | 1.00 | 1.00 | 0.11 | A31 - A32 | 1.00 | | | 1.00 | | |
| A10 - A11 | 1.00 | 0.00 | 1.00 | 1.00 | 0.05 | 1.00 | A32 - A33 | 0.06 | | | 1.00 | | |
| A11 - A12 | 1.00 | 1.00 | | 1.00 | 1.00 | | A33 - A34 | 0.42 | | | 1.00 | | |
| A12 - A13 | 1.00 | 1.00 | | 1.00 | 1.00 | | A34 - A35 | 1.00 | | | 1.00 | | |
| A13 - A14 | 1.00 | 1.00 | | 1.00 | 0.06 | | A35 - A36 | 1.00 | | | 0.37 | | |
| A14 - A15 | 1.00 | 1.00 | | 1.00 | 1.00 | | A36 - A37 | 1.00 | | | 1.00 | | |
| A15 - A16 | 1.00 | 1.00 | | 1.00 | 0.02 | | A37 - A38 | 1.00 | | | 1.00 | | |
| A16 - A17 | 1.00 | 1.00 | | 1.00 | 0.01 | | A38 - A39 | 1.00 | | | 0.00 | | |
| A17 - A18 | 1.00 | 1.00 | | 1.00 | 1.00 | | A39 - A40 | 1.00 | | | 0.09 | | |
| A18 - A19 | 1.00 | 1.00 | | 1.00 | 1.00 | | A40 - A41 | 1.00 | | | 0.09 | | |
| A19 - A20 | 1.00 | 1.00 | | 1.00 | 1.00 | | A41 - A42 | 1.00 | | | 1.00 | | |
| A20 - A21 | 0.00 | 1.00 | | 1.00 | 1.00 | | A42 - A43 | 1.00 | | | 1.00 | | |
| A21 - A22 | 0.96 | 1.00 | | 1.00 | 1.00 | | | | | | | | |

**Table 5.** Comparison between the same session of each couple of groups during the same session. The text explains that we performed a Wilcoxon rank sum test (equivalent to the Mann-Whitney test). The cells in red contain the value of p of the statistically significant results ($p < 0.05$).

| Session | PGC-YGC | PG1-YG1 | PG2-YG2 | PG1-PGC | PG2-PGC | PG1-PG2 | YG1-YGC | YG2-YGC | YG1-YG2 | PG1-YG2 | PG1-YGC | PGC-YG2 | PG2-YG1 | PG2-YGC | PGC-YG1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.11 | 0.00 | 0.01 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| A01 | 0.00 | 0.83 | 0.13 | 0.09 | 0.00 | 0.12 | 0.33 | 0.01 | 0.47 | 0.39 | 0.09 | 0.03 | 0.30 | 0.34 | 0.02 |
| A02 | 0.00 | 0.07 | 0.05 | 0.22 | 0.00 | 0.01 | 0.00 | 0.00 | 0.86 | 0.07 | 0.00 | 0.15 | 0.07 | 0.35 | 0.10 |
| A03 | 0.00 | 0.00 | 0.04 | 0.02 | 0.84 | 0.02 | 0.00 | 0.00 | 0.24 | 0.00 | 0.45 | 0.01 | 0.42 | 0.00 | 0.22 |
| A04 | 0.01 | 0.00 | 0.08 | 0.01 | 0.01 | 0.00 | 0.01 | 0.05 | 0.56 | 0.00 | 0.00 | 0.17 | 0.02 | 0.86 | 0.35 |
| A05 | 0.09 | 0.00 | 0.42 | 0.01 | 0.49 | 0.00 | 0.48 | 0.65 | 0.74 | 0.00 | 0.00 | 0.07 | 0.42 | 0.37 | 0.07 |
| A06 | 0.00 | 0.64 | 0.00 | 0.01 | 0.00 | 0.04 | 0.00 | 0.00 | 0.01 | 0.29 | 0.00 | 0.03 | 0.03 | 0.00 | 0.00 |

**Continued**

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A07 | 0.00 | 0.72 | 0.00 | 0.14 | 0.00 | 0.26 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.03 | 0.10 | 0.00 | 0.08 |
| A08 | 0.00 | 0.13 | 0.29 | 0.16 | 0.04 | 0.70 | 0.00 | 0.00 | 0.34 | 0.38 | 0.00 | 0.02 | 0.07 | 0.00 | 0.31 |
| A09 | 0.00 | 0.42 | 0.00 | 0.32 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.10 | 0.00 | 0.01 |
| A10 | 0.00 | 0.09 | 0.00 | 0.31 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.22 | 0.00 | 0.83 | 0.23 | 0.00 | 0.00 |
| A11 | 0.00 | 0.30 | 0.00 | 0.00 | 0.55 | 0.00 | 0.00 | 0.00 | 0.01 | 0.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| A12 | | 0.01 | 0.00 | | | 0.00 | | | 0.00 | 0.93 | | | 0.00 | | |
| A13 | | 0.02 | 0.00 | | | 0.00 | | | 0.40 | 0.00 | | | 0.00 | | |
| A14 | | 0.02 | 0.16 | | | 0.01 | | | 0.00 | 0.38 | | | 0.00 | | |
| A15 | | 0.37 | 0.26 | | | 0.23 | | | 0.23 | 0.65 | | | 0.01 | | |
| A16 | | 0.00 | 0.00 | | | 0.42 | | | 0.00 | 0.00 | | | 0.13 | | |
| A17 | | 0.86 | 0.69 | | | 0.55 | | | 0.27 | 0.32 | | | 0.56 | | |
| A18 | | 0.76 | 0.04 | | | 1.00 | | | 0.00 | 0.04 | | | 0.76 | | |
| A19 | | 0.98 | 0.42 | | | 0.42 | | | 0.92 | 0.85 | | | 0.35 | | |
| A20 | | 0.00 | 0.04 | | | 0.54 | | | 0.33 | 0.00 | | | 0.00 | | |
| A21 | | 0.00 | 0.06 | | | 0.01 | | | 0.45 | 0.00 | | | 0.01 | | |
| A22 | | 0.55 | 0.72 | | | 0.24 | | | 0.01 | 0.40 | | | 0.48 | | |
| A23 | | 0.01 | 0.08 | | | 0.00 | | | 0.54 | 0.03 | | | 0.24 | | |
| A24 | | 0.82 | 0.55 | | | 0.19 | | | 0.20 | 0.67 | | | 0.04 | | |
| A25 | | 0.08 | 0.02 | | | 0.14 | | | 0.00 | 0.84 | | | 0.00 | | |
| A26 | | 0.00 | 0.00 | | | 0.00 | | | 0.00 | 0.00 | | | 0.29 | | |
| A27 | | 0.00 | 0.00 | | | 0.00 | | | 0.00 | 0.09 | | | 0.00 | | |
| A28 | | 0.00 | | | | | | | 0.00 | 0.00 | | | | | |
| A29 | | 0.00 | | | | | | | 0.00 | 0.82 | | | | | |
| A30 | | 0.00 | | | | | | | 0.00 | 0.28 | | | | | |
| A31 | | 0.68 | | | | | | | 0.00 | 0.01 | | | | | |
| A32 | | 0.99 | | | | | | | | | | | | | |
| A33 | | 0.00 | | | | | | | | | | | | | |
| A34 | | 0.86 | | | | | | | | | | | | | |
| A35 | | 0.00 | | | | | | | | | | | | | |
| A36 | | 0.01 | | | | | | | | | | | | | |
| A37 | | 0.00 | | | | | | | | | | | | | |
| A38 | | 0.02 | | | | | | | | | | | | | |
| A39 | | 0.00 | | | | | | | | | | | | | |
| A40 | | 0.00 | | | | | | | | | | | | | |
| A41 | | 0.00 | | | | | | | | | | | | | |
| A42 | | 0.00 | | | | | | | | | | | | | |
| A43 | | 0.00 | | | | | | | | | | | | | |

Table 6 summarizes the statistically significant differences between groups. First, we note the maximum percentage of statistically significant differences between adolescents' and parents' closed groups. The second largest percentage of statistically significant differences is between the closed group of adolescents and all the other slow-open groups, parents and adolescents. These results are consistent with the substantial entropy increase in entropy vs. time and the number of participants (see Figure 9) in the closed adolescent group.

The parents' closed group also shows significant differences between the slow-open adolescents and parents' groups. Less significant are the differences between adolescents and parents of group 2.

Figure 9 shows the value of entropy as a function of the number of participants in the different groups.

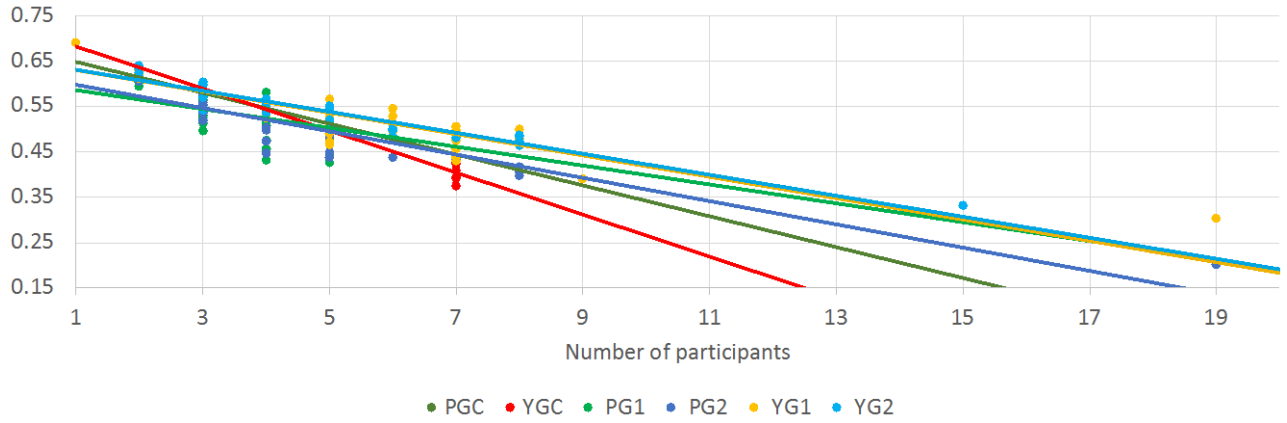
### 4.3. Fourier Analysis

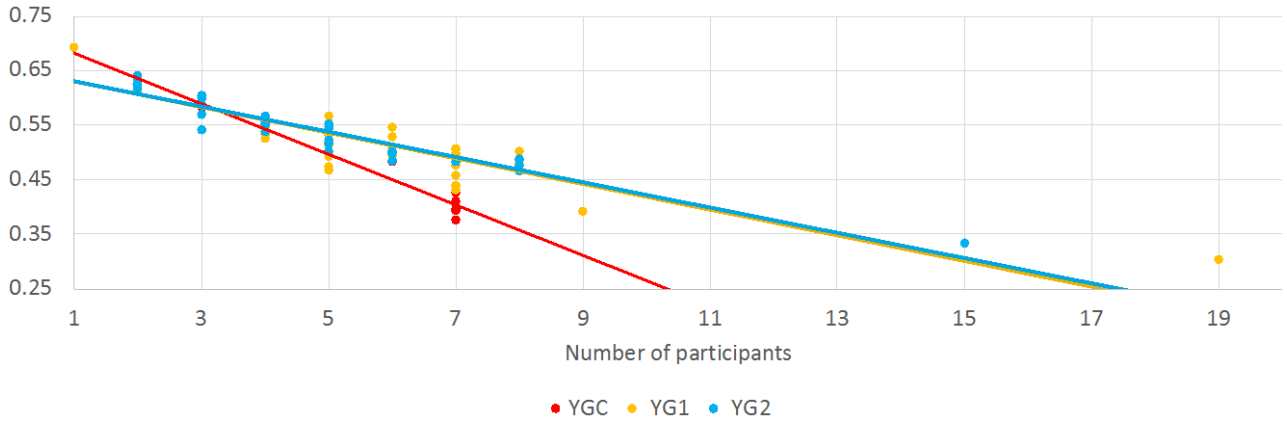
Since we observed fluctuations in the average entropy values versus time, we analyzed it via a Fourier analysis to see whether there are dominant frequencies. The Fourier analysis describes a function via a sum of imaginary exponentials with complex coefficients. In the case of a discrete distribution, the following equation provides the coefficients:

$$a_k = \sum_{n=0}^{N-1} x_n \mathrm{e}^{-\frac{i2\pi}{N}kn}$$

Table 6. Summary of the statistically significant differences between groups reported in Table 5.

| Groups | Different sessions | |
|---|---|---|
| | % | number |
| PC-YC | 91.0% | 11/12 |
| YG1-YC, YG2-YC, PG1-YC | 83.3% | 10/12 |
| PG2-PC | 75.0% | 9/12 |
| PG2-YC | 66.7% | 8/12 |
| PG1-YG1 | 59.1% | 26/44 |
| PC-YG2 | 58.3% | 7/12 |
| PG2-YG2 | 57.1% | 16/28 |
| YG1-YG2 | 56.3% | 18/32 |
| PG1-PG2 | 53.6% | 15/28 |
| PG1-PC, YG1-PC | 50.0% | 6/12 |
| PG1-YG2 | 46.9% | 5/32 |
| PG2-YG1 | 46.4% | 13/28 |


0.75
0.65
0.55
0.45
0.35
0.25
0.15
1
3
5
7
9
11
13
15
17
19
Number of participants
PGC
YGC
PG1
PG2
YG1
YG2


0.75
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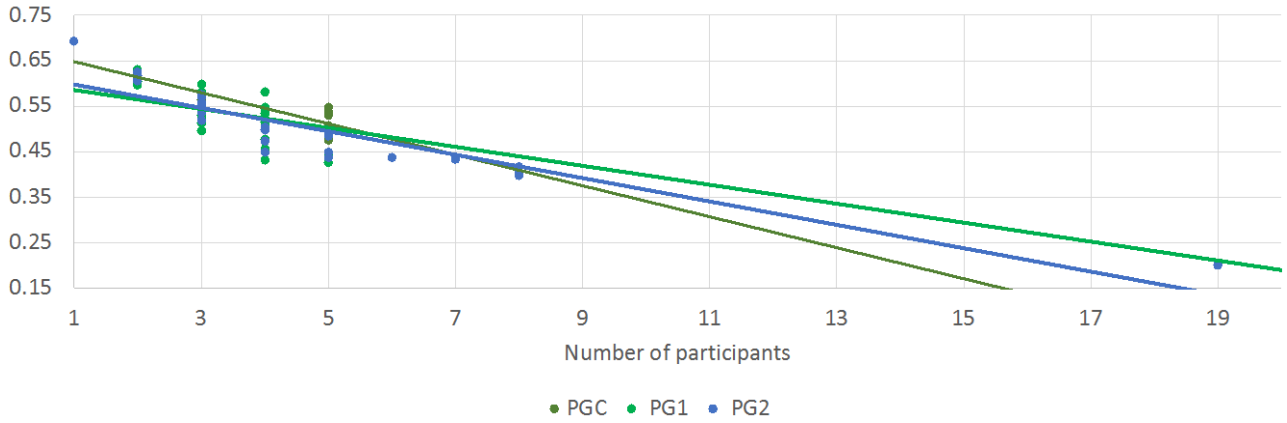
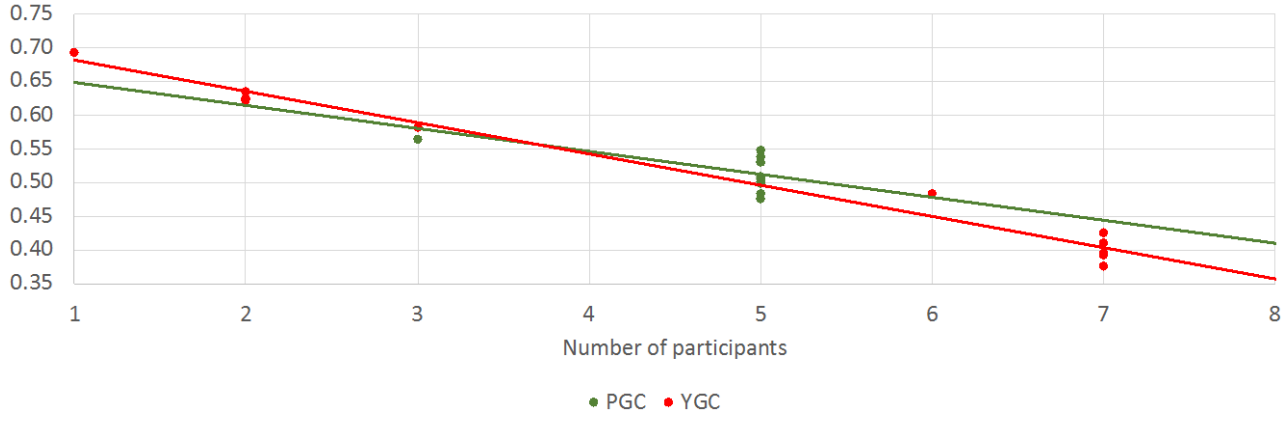
11
13
15
17
19
Number of participants
YGC
YG1
YG2


0.75
0.65
0.55
0.45
0.35
0.25
0.15
1
3
5
7
9
11
13
15
17
19
Number of participants
PGC
PG1
PG2


0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
1
2
3
4
5
6
7
8
Number of participants
PGC
YGC

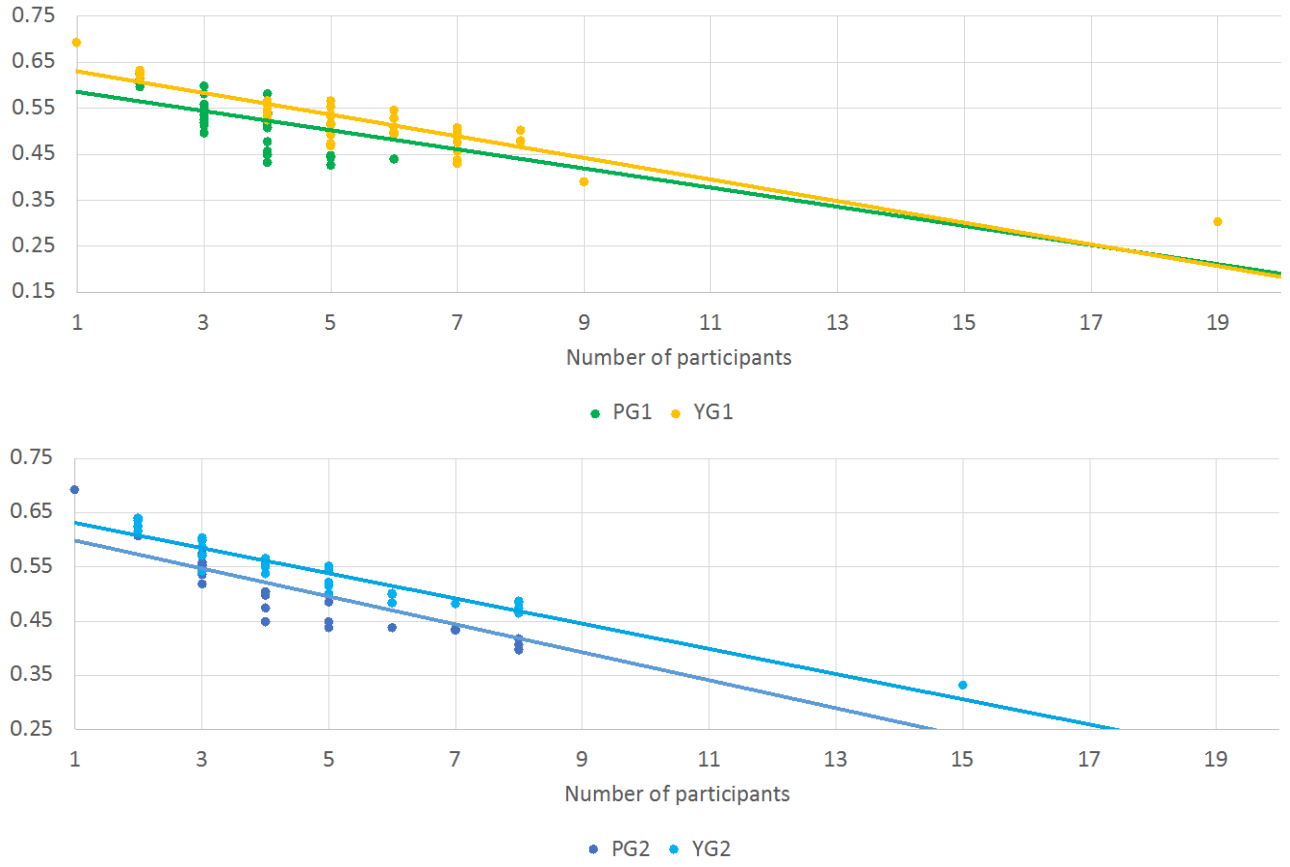



**Figure 9.** We present here the behavior of the entropy as a function of the number of participants in the different groups. For clarity, we report the comparison between the different pairs of groups.

where $N$ is the total number of data points. From this equation, we can reconstruct the original points via the inverse Fourier transform:

$$x_n = \frac{1}{N}\sum_{k=0}^{N-1} a_k e^{\frac{i2\pi}{N}kn}$$

In the above formula, we can interpret $k$ as a frequency, i.e., the number of complete oscillations of the amplitude $a_k$ in the period under study. Usually, the frequency is calculated as $k/N$. However, in our case, this would give us the number of oscillations per unit time, in this case, weeks. Preferring to use the whole training session as the "unit of time," we consider $k$ as the frequency. The Fourier transform *moves* the description of a phenomenon from a space of values as a function of time to a space of complex amplitudes as a function of their corresponding oscillation frequency. In the case of a discrete function, the Nyquist theorem (Hammersley & Grenander, 1960) limits the frequencies we can measure from the data. Since, according to this theorem, there must be at least two samplings per period to determine a frequency, the maximum frequency that can be measured is $N/2$. The frequencies $k > N/2$ are sometimes called "time backward frequencies," and we cannot interpret them as real frequencies. In the case where the values are real numbers, as it is in our case, the following relation

holds:

$$a_{\frac{N}{2}-i} = -a_{\frac{N}{2}+i}, i \in \left[0, \frac{N}{2}-1\right]$$

from which $a_{N/2} = 0$. After some trivial algebra, we rewrite the inverse transformation as:

$$x_n = \frac{a_0}{N} + \frac{2}{N}\sum_{k=1}^{N/2-1} |a_k| \cos\left(k\frac{2\pi n}{N} + \operatorname{atan}\frac{\operatorname{Im}(a_k)}{\operatorname{Re}(a_k)}\right)$$

In this formula $\frac{a_0}{N}$ is the average value of the function of time, while $\frac{2}{N}|a_k| = \frac{2}{N}\sqrt{\operatorname{Re}(a_k)^2 + \operatorname{Im}(a_k)^2}$ is the contribution of frequency $k$ to our data. In the trivial case of a sinusoidal function of period $N/k$, $|a_k| = \frac{N}{2}$; $a_{i\neq k} = 0$, $i \in \left[0, \frac{N}{2}\right]$.

There are two important points to be considered when using a Fourier transform for a finite number of points. The first is that the number of points should be even to obtain the best result. This fact has to do with the symmetrization of "forward" ($k \leq N/2$) and "backward" ($k > N/2$) frequencies. Fortunately, in our case, all our samples have an even number of points if we include Qst0. The second point is that the observations are supposed to be equidistant in time. This condition is verified in our case since the sessions are weekly. There is a hiatus of 14 weeks (from June to September 2016) between sessions 14 and 15 for PG1 and YG1. Since we could not find any reasonable correction, we mention this as a limitation of our analysis. Since we are interested in the fluctuations of the average entropy, we have detrended the data, removing from the value of entropy the linear fit of the values as a function of the sessions.

The frequencies are the number of complete pulsations between Qst0 and the end of the training. The period is the length of a complete oscillation. There is, therefore, an inverse relationship between the frequency and the length of the period for each training. After analyzing the amplitudes, we kept only the first three since the others are much smaller.

Figure 10 reports the result of our analysis. The parent and adolescent closed groups have the same first and third frequencies, while the second differs. We could not detect a typical pattern for the slow-open groups. The second frequency of the parent slow-open groups is markedly higher than the adolescent's corresponding one. The adolescents' slow-open group 2 has a third frequency of 14, the highest of all other groups. The closed groups have the smallest second frequency compared to all other groups.

Table 7 summarizes the Fourier analysis and reports the absolute and percentage entropy difference between Qst0 or Qst1 and the end of the training. As already remarked, we note an increase in entropy in all groups.

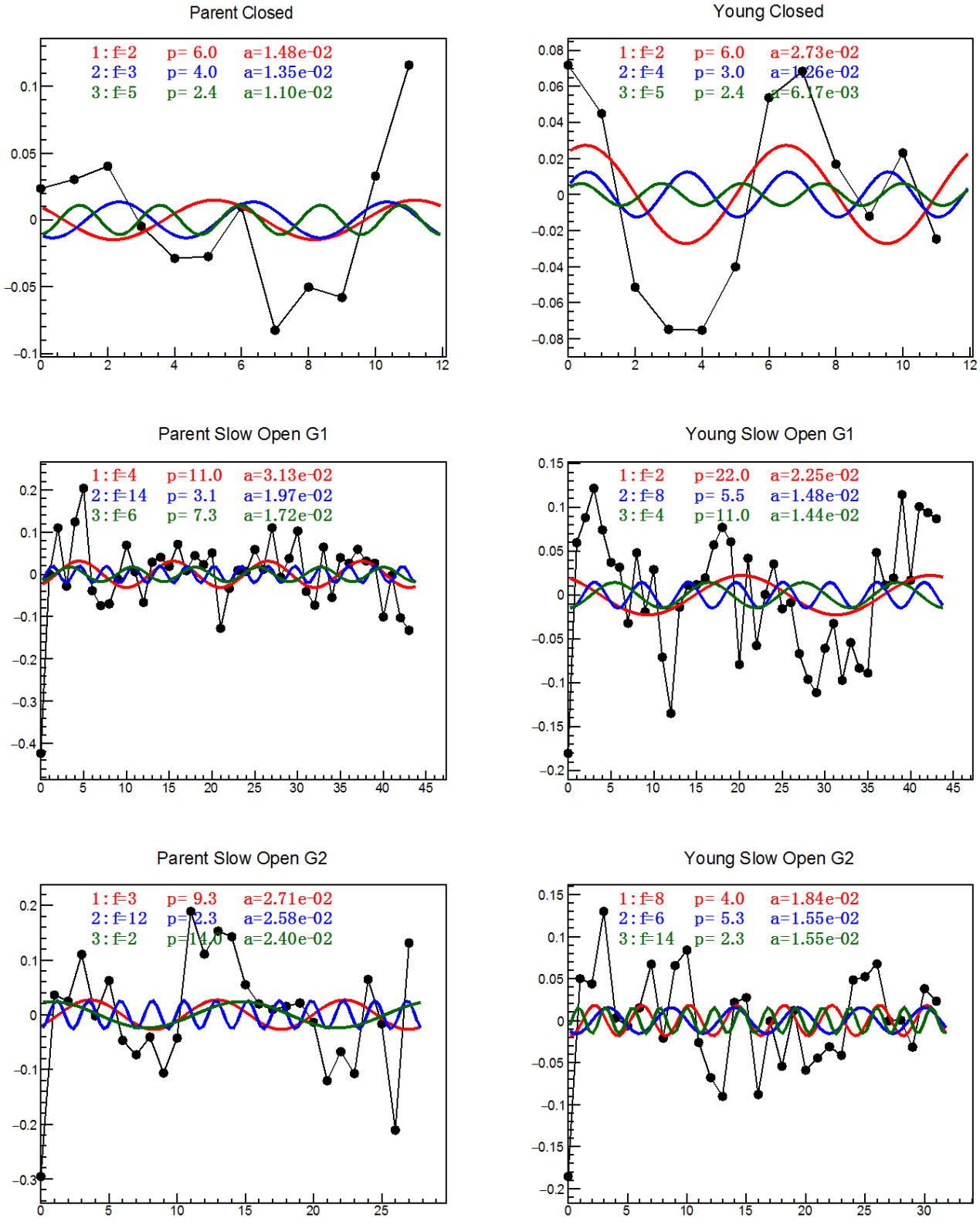



**Figure 10.** Results of the Fourier analysis of the average entropy as a function of the session number. We report the three frequencies with the largest amplitudes, the corresponding period, and the amplitude (in colors red, blue, and green, corresponding to decreasing amplitudes). We have excluded the trivial case of $k = 1$, where there is a single cycle in the whole period. We have also plotted the contributions of the three dominant frequencies (in black).

Table 7. This table presents the results of the entropy analysis. The first column is the average entropy of the Qst0 answers. The second column is the average entropy of the Qs1 answers. The third column is the average entropy of the final session, while the fourth is the number of sessions (without and with the 0th one). The fifth column is the difference in average entropy between the 0th and the final questionnaire, and the sixth column is the difference normalized by the number of sessions. The seventh and eighth columns are the same for the difference with the average entropy of the first session. Columns 9 - 11 are the three principal frequencies of the entropy evolution, while columns 12 - 14 are the corresponding periods.

| *Group* | Q0 | Q1 | Qf | #sessions | ΔQ0-Qf | ΔQ0-Qf norm | ΔQ1-Qf | ΔQ1-Qf norm | 1st *f* | 2nd *f* | 3rd *f* | 1st p | 2nd p | 3rd p |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *PG*1 | 0.23 | 0.66 | 0.74 | 43 (+1) | 0.51 | 0.012 | 0.08 | 0.002 | 4 | 14 | 6 | 11.0 | 3.1 | 7.3 |
| *PG*2 | 0.29 | 0.63 | 1.00 | 27 (+1) | 0.71 | 0.025 | 0.37 | 0.014 | 3 | 12 | 2 | 9.3 | 2.3 | 14.0 |
| *PGC* | 0.77 | 0.78 | 0.90 | 11 (+1) | 0.14 | 0.011 | 0.13 | 0.011 | 2 | 3 | 5 | 6.0 | 4.0 | 2.4 |
| *YG*1 | 0.44 | 0.68 | 1.00 | 43 (+1) | 0.56 | 0.013 | 0.32 | 0.007 | 2 | 8 | 4 | 22.0 | 5.5 | 11.0 |
| *YG*2 | 0.48 | 0.72 | 0.92 | 31 (+1) | 0.44 | 0.014 | 0.19 | 0.006 | 8 | 6 | 14 | 4.0 | 5.3 | 2.3 |
| *YGC* | 0.57 | 0.59 | 1.00 | 11 (+1) | 0.43 | 0.036 | 0.41 | 0.037 | 2 | 4 | 5 | 6.0 | 3.0 | 2.4 |

Independently of the number of sessions, the first frequencies are between 2 and 8. On the contrary, the second and third frequencies have a much wider range, i.e., from 4 to 14 and 2 to 14, respectively.

Table 7 shows that the entropy difference from start to end is not proportional to the number of sessions. The closed adolescents group shows the largest entropy increase rate from both Qst0 and Qs1 to the end of the training.

As shown in Figure 11 and Figure 12 we cannot correlate the frequencies found with the Fourier transform with the differences in entropy at the training start and end. As a general remark, higher frequencies correspond to larger differences between the training start and end, but the trend is irregular. For the second frequency, the entropy difference increases with the frequency, up to the value of 8, and then decreases, indicating a possible rebalancing of the entropy towards lower values when the fluctuations are very rapid. On the other hand, the closed adolescent group presents a different trend from other groups, with much higher entropy differences than the other groups. The relationship between the first and third frequencies and the entropy difference does not present a discernible trend.

Figure 12 left presents the difference in entropy between Qst1 and the end of the training normalized by the number of sessions as a function of the three principal frequencies.

The second frequency shows a possible correlation between groups having high entropies and an increase in the normalized entropy delta, with a decrease starting from a frequency of 12. The entropy difference shows no clear dependence on frequencies 1 and 2. Here too, the adolescents' closed group shows a large difference in the normalized entropy and its absolute values.

For all the other groups, by increasing the second frequency value, the normalized and absolute entropy difference increase to 8 for the absolute and 12 for the normalized.

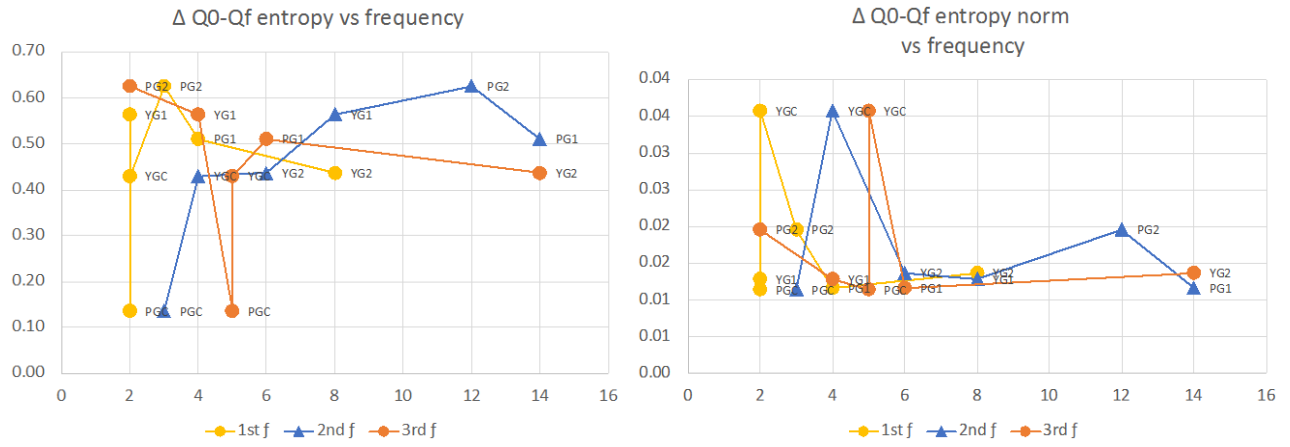



**Figure 11.** Left: entropy difference between Qst0 and the last questionnaire Qstf as a function of the three principal frequencies. Right: entropy difference between Qst0 and the last questionnaire normalized by the number of sessions as a function of the three principal frequencies.

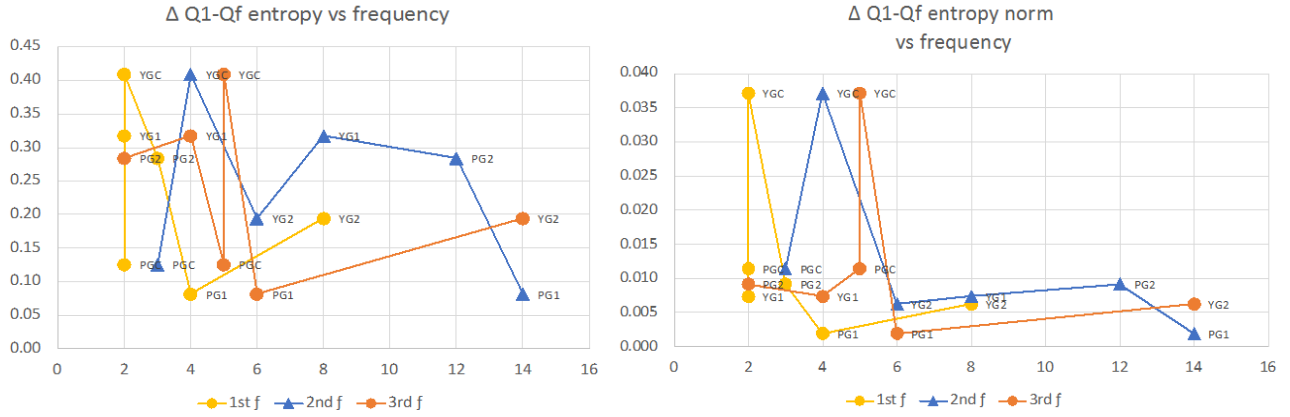



**Figure 12.** Left: entropy difference between Qst1 and the last questionnaire Qstfas a function of the three principal frequencies. Right: entropy difference between Qst1 and the last questionnaire normalized to the number of sessions as a function of the three principal frequencies.

Considering the entropy difference from Qst0 to the end of the training (Figure 12), we see an increase with increasing frequencies (second frequency) up to 12, after which the entropy difference decreases.

In the entropy difference between Qst0 and the end of the training, we do not see the peak present in the other graphs, i.e., normalized entropy difference from Qst0 and normalized and absolute entropy difference from Qst1 and the end of the training. There are differences in the entropy change if we consider Qst0 or Qst1 as the starting point for the slow-open groups, while the behaviors of the closed groups are very similar in the two cases. The entropy trends vs. the first and third frequencies are difficult to interpret.

The trend of the entropy differences from Qst0 to the final one normalized by the number of sessions is like the one from Qst1 to the final one, while this similarity is less evident for the absolute values. This behavior is because the peak in the closed adolescent group is not present in the absolute difference from Qst0 to the final one.

In Figure 13 and Figure 14 we correlate the periods found with the Fourier transform with the average entropy differences in entropy from the start to the end of the training.

The absolute entropy differences from Qst0 and Qst1 to the end vs. the second period shows a similar trend, with a diminution for period 2.3 and an increase for period 5.3.

The normalized entropy difference from Qst0 and Qst1 to the end vs. the second period shows a peak for period 3, followed by an irregular trend to period 5.3.

## 5. Discussion

This experiment was conducted in 2017-2019 during Dialectical Behavior Therapy skills training at the Psychiatric Service of the Basurto University Hospital in Bilbao, Spain. Seven publications have reported the results of similar experiments

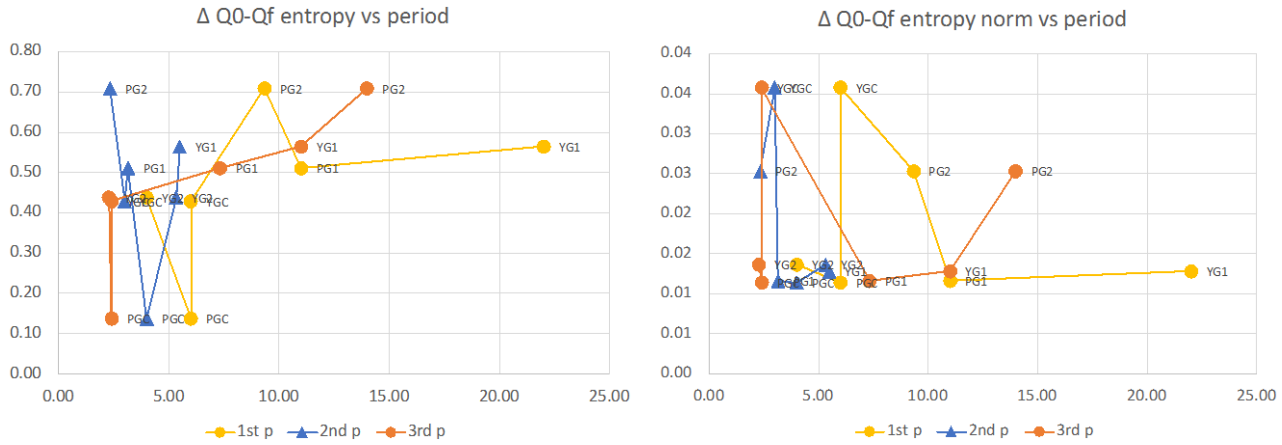



Figure 13. Left: entropy difference between Qst0 and the last questionnaire as a function of the three principal periods. Right: entropy difference between Qst0 and the last questionnaire normalized to the number of sessions as a function of the three principal periods.

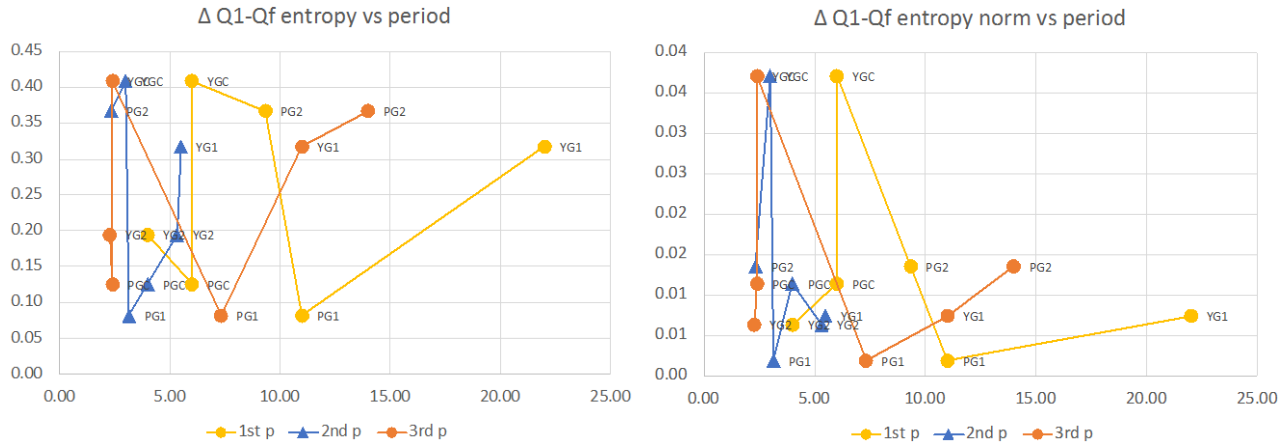



Figure 14. Left: entropy difference between Qst1 and the last questionnaire as a function of the three principal periods. Right: entropy difference between Qst1 and the last questionnaire normalized to the number of sessions as a function of the three principal periods.

(Fernandez-Rivas et al., 2020, 2021a, 2021b; Trojaola-Zapirain et al., 2014, 2015, 2016, 2019). This series of works points out the existence of a "group unconscious" operating according to the "basic assumptions" postulated by W. Bion. According to him, the psyches of the individuals participating in a group immediately bond together into a group psychical entity that evolves during the group's existence. Bion has coined the term "valency" for this effect, more akin to a tropism than a goal-directed attitude. The group setting enhances this effect since, according to Bion, groups "amplify emotional reactions, resulting in a combustible process of emotional contagion" (Bion, 1961).

Several authors have observed that it is impossible to measure the unconscious directly (Atmanspacher, 2004; Cerf & Adami, 1997, 1998). To avoid this difficulty, we have elaborated a protocol for an "indirect measure" via our "absurd questionnaire" in a group setting. With this experiment, we want to see whether a mental state—the hypothesized entanglement of the individuals' minds in a group setting—can have material effects, such as the answers to our questionnaire.

The longitudinal analysis does not indicate a common behavior or a similar trend between the groups. However, the slow-open groups' parents and group 1 adolescents show statistically significant differences between Qst0 before the start of therapy and the results of the first training session.

Considering the differences between groups, we note that the percentage of the statistically significant differences is maximum between the adolescents and the parents of the closed group. We also find the tendency of a significant difference in entropy between the parents and the adolescents in the closed and slow-open groups. From these results, it seems possible to conclude that entropy's evolution depends more on the age group (parents or adolescents) in closed and slow-open groups than between the slow-open groups.

The trend of entropy is steeper in the adolescents' closed group of young people, which is consistent with the increase in time vs. the number of participants.

Observing the absolute or normalized entropy vs. frequency, the peculiar trend of the adolescents' closed group contrasts with the general trend. For the other groups, the entropy difference increases and diminishes for a specific frequency value.

In all the groups, the entropy at the start of the training is lower than at the end. In addition, the differences in entropy at the start and the end of the training, absolute or normalized by the number of sessions (see **Table 7**), appears to be correlated with the second frequency found with the Fourier transforms. However, this correlation is not present for the first and third frequencies. As the second frequency increases from 8 to 12, so does the difference in entropy between Qst0 or Qst1 and the end of the training, except for the adolescents' closed group, which shows a very high entropy difference for low values of the second frequency.

Instead, we observe that an increased group dynamics "rhythm"—as measured by the second frequency in terms of amplitude—positively correlates with the change in entropy, but only the absolute, not the normalized, and only the difference from Qt0 to final during the training.

We can suppose a qualitative correlation between the increase in entropy and the group drop-offs. However, we cannot infer from this a cause-effect link. In other words, we cannot say whether the participants leaving the group cause an increase in entropy or, instead, if a more entropic group dynamic pushes participants to leave the group.

It is interesting to note that the first frequency found with Fourier analysis is independent of the duration of the therapy and represents a "pulsation" in the group dynamic, regardless of the type of the group, closed or slow-open.

## 6. Conclusion

In recent papers (Fernandez-Rivas et al., 2021a, 2021b), we find a significant social and generational environment influence depending on the setting (slow-open group versus closed group). In the present study, we could hypothesize that generational differences are more effective than the setting in influencing the group dynamic.

Moreover, particularly for adolescents, the feeling of identity loss introduced by the "group continuum" could bring stress and anxiety and ultimately provoke the exit from the group, above all in the closed group setting.

The group continuum originates from the entanglement of individual psyches forming a group entity endowed with its own identity. This "loss of clanity" towards the original environment may create an intense discomfort and lead to a flight from the group situation (group continuum and entanglement), either leaving the therapy altogether or, more discretely, reverting to the choices of the 0th questionnaire.

We may interpret the eventual return to the preferred image as an expression of clanic loyalties. In that case, these clanic loyalties, even if very apparent for adolescents in dress code and above all body look when moving from the family to the friend's envelope, are more present in parents, albeit with a more hidden, less open attitude.

We supposed in a previous study that this entanglement is weaker in slow-open than in closed groups, but regarding entropy, we find the dynamic more influenced by the generational status than by the therapeutic setting.

The slow-open setting probably reinforces the Dialectical Behavior Group Therapy participation, allowing adolescents and parents to experience a moderated conflict with clanic preexistent loyalties and a more relaxed interaction with the group continuum. However, the trend of the closed group of young suggests that the conflict between friend clan, family clan, and group continuum is particularly acute in this setting and can generate a sizeable dropout.

Suppose we want to extract a therapeutical suggestion from our study. In that

case, the group's action is firmly "countered" by the participants' "clanic loyalties." Although this effect is less pronounced in the slow-open setting, slow-open group therapists must remember that the "environment" remains strong and should devote special care to the emergence of loyalty conflicts and identity loss angst (loss fear or "Angst vor Verlust") during the training.

The clear finding is the augmentation of entropy, from Qst0 and Qs1 to final in all the groups regardless of the type (closed or slow-open) and a possible common frequency (considering the first one), the number of complete cycles in the interval regardless of the type of group but also the length of the interval.

It could probably be interesting to perform a new study on Dialectical Behavior Therapy skills training in slow-open groups, focused on the entropy fluctuations from Qst0 and Qst1 for a longer time, for instance, at least one year.

## Conflicts of Interest

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

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