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FUNDAMENTAL, QUANTITATIVE TRAITS OF THE "SOCIOTYPE":

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ABSTRACT

In whatever domain of life, from cells to organisms to societies, communicative exchanges underlie the formation and maintenance, and decay, of the emerging collective structures. It can be clearly seen in the human social world. The different classes of social bonds in a complex society revolve around, and are intimately related with, the communicative relationships that every individual entertains—essentially via face-to-face conversation. In the present work we have investigated the fundamental metrics of both social bonds and communicative exchanges along the development of the "sociotype" construct. It is a new approach developed by the authors within the *genotype-phenotype-sociotype* conceptual triad. The sociotype means the relative constancy, or better the similar fabric, of the social world in which each individual life is developed. In order to ascertain the metrics of these two fundamental quantitative traits inherent in the sociotype, a fieldwork involving a total of 1,475 individuals (68.59% female, and 49.79 mean age, SD=21.47) was carried out. The four relational realms of family, friends, work/study, and acquaintances were investigated. The overall results about conversation time (an average of 220 min/day), and about the number of social bonds (an average of 98), differ from previous assumptions, such as Dunbar's number or Killworth's number. Other results about gender, age, and use of social media and Internet contribute to highlight significant differences among the different social segments, and particularly the diminished "sociotype" of the elderly. Finally, it is curious that a non-Gaussian distribution has been obtained for the specific population allotment of these metrics, and intriguingly the Planckian distribution equation (PDE) appears to be a most cogent fit.

Keywords: Sociotype; Social networks; Number of contacts; Conversation time; Attention economy; Planckian distribution equation (PDE).

1. Introduction

The phenomenon of communication is crucial in the origins and organization of life, at whatever levels of complexity (Conrad, 1996). Somehow, we have to admit, communication itself entails and underpins the core complexity in all living and social systems. It may be exemplified in the conceptual triad that inspires the present work: *genotype, phenotype, and sociotype* (Marijuán et al., 2017). It took decades, if not centuries, of intense research to decipher the "information flow" associated with the genotype molecular structure of DNA, to RNA, to proteins, etc. A similar conceptual hardship has surrounded the hyper-complex cellular networks and tissues linked via messengers and the interpretive cellular signaling systems of the phenotype (Marijuán et al., 2015). And something comparable seems to occur in the social case, concerning the sociotype: What can be posited theoretically about the intricate nature and mutual interrelationship of social bonds and communicative exchanges? Actually, endless discussions surround the most primary questions: *With whom do we talk? How much are we talking?* These two really elementary questions of daily life can hardly be answered scientifically, even in present day research. In spite of the fact that a number of disciplines are involved in the analysis of communicative phenomena – from sociology and social psychology, to anthropology, communication studies, social networks science, "social physics", biosemiotics, etc. – none of them seems to ask these two questions together. Trying to minimally fill in that gap is the goal of the present paper. Our point of view will be multidisciplinary, necessarily closer to social sciences' concepts and methodology, but always keeping an eye on the biological foundations of information and communication (Conrad, 1996; Marijuán, 1996, 1998).

Curiously, early sociologists, and particularly Emile Durkheim, were close to the present query when they aimed at the basic behaviors knitting together human societies – the "mechanical solidarity" among the members of societies via social bonds based on common sentiments and shared moral values (Durkheim, 1895) – but these views were developed

towards the macro-structure, far from contemplating a micro-sociological quantification. Similar criticisms could be made about the works of other classical sociologists such as Max Weber and Talcott Parsons, who were approaching the basics of sociality from alternative directions (Weber, 1905; Parsons, 1951). George Simmel, however, focused on the social relation per se, on sociability and its absence: loneliness. At the beginning of the XXth Century, he was one of the first to describe the paradoxical situation of "been modern": "one *nowhere* feels as *lonely* and lost as in the *metropolitan crowd*" (Simmel, 1903, p.640). In another work (Simmel, 1971), he was stating that social forms become autonomous and do not meet any practical purpose, only for reason of the social forms themselves. They are 'recreational' forms of sociality devoid of all pragmatic content, when people aspire to participate in the 'world' of society as an end in itself.

In their own way, classical anthropologists did care about answering these elementary questions (Boas, 1911; Malinowski, 1944; Mead, 1964; Lévi-Strauss, 1981); but it was done indirectly, via the exploration of themes such as family structure, kinship, social relations, gender, customs, etc. Perhaps more to the point, a vast corpus of paleo-anthropological and evolutionary literature has been developed in last decades around the emergence of human sociality and human language – the "social brain" – out from the Anthropoidea background (Allman, 1999; Baron-Cohen et al., 1999; Badcock and Crespi, 2008; Hill et al., 2011). The works of Robin Dunbar, for instance, have covered a variety of aspects concerning the 'natural' size of social networks demanded by the social brain of individuals and the evolutionary *grooming* origins of language (Dunbar, 1996, 2004).

Studies directly focused on social networks by Mark Granovetter, Peter Killworth, Russell Bernard and others have left a more nuanced approach to the structure of social bonds, and relevant quantitative data about the social networks formed around individuals have been obtained (Granovetter, 1973; Wellman, 1982, 1988; Killworth et al., 1990; Bernard et al., 1991).

However, these approaches have not explored the crucial role of conversation in the making and breaking, in the maintenance and actualization of such social bonding structures, perhaps with a topical exception—sex differences in conversation. It is a topic that has emerged as a subject of both public and scientific interest in connection with gender studies (Lakoff, 1975; James and Drakich, 1993; Litosseliti, 2006; Mehl et al., 2007). Also during the 1970s and '80s, Erving Goffman's book on "Forms of talk" was a pioneering contribution to qualitative research in communication studies (Goffman, 1981). He analyzed interactional face-to-face communication in ordinary conversations and verbal exchanges, establishing the fundamental role of frames to determine the course of conversation.

More generally, the renewed interest for communication studies has led to a number of works around relevant aspects of conversation (discourse analysis, semiotics, pragmatics, politics, etc.). For instance, Ronald Inglehart (2000, 2015) included different variables in World Values Survey to measure the frequency of people's talk with their family and friends, to get information about each country's values, and about the world's values in a study of 60 countries. Using Inglehart's model and database, Mira Sotirovic and Jack M. McLeod (2001) analyzed interpersonal discussion and the trends of political participation. Nevertheless, until the last decade, estimates of natural conversation for extended periods of time were fairly absent (Mehl et al., 2007).

The new technologies of information and communication have rekindled the interest in interpersonal exchanges, including conversation metrics, and have produced plenty of experimental data, although often more focused on cell-phone usage or on the interaction via new technologies than on natural conversation *per se* (Pinheiro, 2011; Grandjean, 2016). In parallel, a number of related works in network science have covered the sizes, distributions, and many other characteristics of social networks in very different contexts: companies, neighborhoods, cities, regions, countries, healthcare, etc. (Barabási, 2003; Strogatz, 2001;

Fowler and Christakis, 2008; Hollstein, 2011; Bidart and Charbonneau, 2011; Christakis and Fowler, 2018). Important work related to the communication flow in complex organizations and professional groups has been performed by Alex P. Pentland under the "social physics" paradigm (Pentland, 2014; Almaatouq et al., 2016; Yuan et al., 2018). *Who talks to whom* becomes an important indicator of the distribution of effective power relationships and the efficiency of professional teamwork within complex organizations. However, the paucity of inquiry about natural conversation time, face-to-face, has remained.

In the present work, we have aimed at establishing the conjoint metrics of both social bonding structures and social interrelationships (essentially, face-to-face or natural conversation) in between individuals. This has been done in the framework of the "sociotype" study, a new construct developed by the authors within the conceptual triad genotype-phenotype-sociotype that allows the theoretical integration of essential qualitative and quantitative aspects of social networking (Marijuán et al., 2017; see also Berry, 2011; Berry and De Geest, 2012). The sociotype means the average social environment that is adaptively demanded by the 'social brain' of each individual. It may include a variety of quantitative and qualitative aspects. For instance, the sociotype questionnaire (SOCQ), developed by the authors (Marijuán et al., 2017), contemplates the relational dimensions of family, friends, work/study, and acquaintances, which are covered by means of 12 (+4) items. It is a consistent and reliable enough questionnaire that strongly correlates with well established metrics of loneliness, anxiety, general health, and personality types. Subsequently, in the present work we have investigated the respective figures – structural and communicational – corresponding to the whole relationships of the individual and to each one of the four domains of sociality: family, friends, work/study, and acquaintances. In this pursuit, the two questions of *how much are we talking* and *with whom* have been quantitatively surveyed for the same population involved in the development of the SOCQ questionnaire. All the participants were interrogated about the

time spent in conversation and about the number of social contacts within the different relational domains. The results obtained about conversation time have been analyzed and compared with some of the scarce literature available. The same about the results found on the number of social bonds—although in this case the literature is far more extended, almost overwhelming. An interesting point concerns the extent to which the present results differ from well-known assumptions such as the Dunbar's number (Dunbar, 1996) or from Killworth's number (Killworth et al., 1990). Further, the inspection of relational differences due to age, gender, and use of social media and Internet contributes to highlight important differences in communication practices among the different segments, and particularly evidences the diminished "sociotype" of the elderly. More in general, these results concur with existing literature on the influence on specific life events on relational patterns (Wellman, 2007; Bidart and Charbonneau, 2011; Hollstein, 2011). Intriguingly, in relation to the non-Gaussian distribution we have obtained for both the number of social contacts and the associated conversation time, we have explored the plausibility of a recently proposed fit which dovetails with the functioning of an "attention economy": the Planckian distribution equation (Ji, 2017).

2. Material and methods

2.1. Study design

The correlational method, with a cross-sectional individual differences analytical design for data collection, was used. An online internet platform "SurveyMonkey®" was used for data gathering and for statistical support. The questionnaires were self-administered or (when necessary, e.g. the elderly) completed with the assistance of a team researcher or a social worker. In all cases the responses were based on self-report assessments.

2.2. Participants

The fieldwork was developed applying the survey to a convenience sampling of participants (n=1,475) of the general Spanish population, which was considered suitable and large enough for the present exploratory study. Inclusion criteria were: a) being 18 years or older, and b) being able to read and write Spanish. The sample comprised general population mostly recruited from a variety of sources (internet, classrooms, cultural centres, enterprises, residences, home help services, etc.), trying to cover gender and age differences to gain representativeness. All the participants were informed about the study and were asked to complete the questionnaire, either via internet or by face-to-face interviews—the latter used mostly for old people in residences and at home, around 30% of our sample. The final sample was mainly composed of white adults between the ages of 18-95 years (mean=49.79; SD=21.47), 68.59% females and 31.41% males. All participants were Spanish, with diverse regional backgrounds, although mostly from the Aragon region. The main socio-demographic characteristics of participants are described below [3.1].

2.3. Procedure and ethics

The completion of the survey took approximately thirty minutes. Each of the participants was presented with an initial description of the survey (with an informed consent form), which introduced the aims of the study, the advantages/disadvantages of participating, and notification that the data would be processed anonymously. All the participants provided their informed consent before completing the survey, either by reading the project information and providing verbal consent (face-to-face format), or by explicitly accepting the study conditions (online platform). As referred above, a team researcher or a social worker were on hand to give support or additional explanations when required. Given the procedure followed and the kind of generic

data requested, the anonymity of the participants in the survey was granted (in line with Spanish Organic Law 15/99 on Protection of Personal Data). The Ethical Committee of Aragón (CEICA) had previously approved this study (Act: CP13/2014).

2.4. Questionnaires and measurements

1. Sociodemographic variables: sex, age, civil status, residence, education, employment, and income level.
2. Sociotype Questionnaire (SOCQ): it has 16 items that evaluate the quality of relationships through the dimensions: 'Family', 'Friends', 'Acquaintances', and 'Education/Work', with 4 questions for each dimension. It uses a Likert-type scale with 6 response options from 0 (never) to 5 (always). See (Marijuán et al., 2017).
3. Sociotype quantitative questions: another 16 quantitative questions asking for each one of the sociotype dimensions about number of social contacts, daily or weekly averages of conversation, communication channels utilized, and overall satisfaction (so, a total of 17 questions). This set of quantitative questions has been the essential source for the present paper.
4. Other survey's measurements (included in the general survey of the sociotype, but not analyzed in the present paper):
    - General Health Questionnaire (GHQ-12), Spanish version (Sánchez-López and Dresch, 2008).
    - Revised UCLA Loneliness Scale (RULS), Spanish version (Vazquez and Jimenez, 1994).

- Eysenck Personality Questionnaire-Revised (EPQ-R), Spanish version (Ribes, 1995).

2.5. Statistical & data analysis

In the present work we have analyzed the aggregate results from the sociotype quantitative questions. The results from the Sociotype questionnaire were analyzed elsewhere (Marijuán et al., 2017), and the correlations between the quantitative questions analyzed here and the results from the other questionnaires will be the focus of future works.

The statistical analysis was conducted with SPSS software (IBM SPSS Statistics for Windows, Version 19.0). The description of the population characteristics was by means of numbers and percentages for categorical variables; whilst mean, standard deviation (SD), median, and interquartile range (IR) were employed for quantitative variables. As most of the variables did not follow a normal distribution, the Mann-Whitney U test was introduced.

The different distributions obtained for each sociotype dimension regarding the *number of social contacts* and the *communication time* were the essential focus of the present exploration. To study the correlations between them the Pearson correlation coefficient was used.

Additionally, given the non-Gaussian nature of the distributions, we have applied a linear least squares fitting technique exploring the Planckian distribution equation (PDE).

3. Results

3.1. Characteristics of the sample

A total of 1,475 participants completed the study. All of them were Spanish (predominantly from Aragon region, and from other diverse regional backgrounds), 68.59% females and 31.41% males, between the ages of 18-95 years (Mean=49.79; SD=21.47), 49.04% of them with partner or married and 27.98% singles, 50.82% with university studies, 44.06% employed, and 28.11% retired. See Table 1.

[Table 1 here]

3.2. Number of contacts

How many contacts do we have? The results concerning the total number of contacts for each individual are presented in Table 2. We have represented both mean and standard deviation (SD), plus median and interquartil range (IR); it is evident that the values obtained do not conform to the Gaussian Law—we will discuss the Planckian fit below. We have also included the values obtained for the number of contacts in each one of the four relational realms: family, friends, work/study, and acquaintances (see Table 2).

[Table 2 here]

The histogram representing the distribution of the total number of contacts for the whole population makes clear, again, that the normal law is not followed. See Figure 1.

[Figure 1 here]

The same numbers of contacts, now distributed for age (18-35, 36-65, >65) and gender, are shown in Table 3. There appear remarkable differences by both gender and age. Remarkably, women appear with fewer contacts, and older people also have fewer friends and acquaintances than other age segments. See Table 3.

[Table 3 here]

In order to highlight the differences just mentioned on gender and age, we have represented in the block diagrams of Figure 2 the distribution of contacts, now segmented by gender only, or by age only (18-35, 36-65, >65). See Figure 2.

[Figure 2 here]

3.3. Conversation and communication time

How much do we talk? The daily times devoted to interpersonal relationships in the different modalities or communication channels (face-to-face, phone, and whatsapp), expressed in minutes, are presented in Table 4. The data are referred to each one of the sociotype dimensions as well, showing the communication times of the different modalities and the corresponding total time. For simplicity, we have represented only mean and standard deviation (SD) although, again, the values obtained do not conform to the Gaussian Law. See Table 4.

[Table 4 here]

The two histograms in Figure 3 represent the distribution of communication times in the whole population, distinguishing between direct face-to-face conversation (left) versus technologically mediated communication via phone and whatsapp (right). The asymmetry of the distribution is also evident although less pronounced than for the number of contacts. See Figure 3.

[Figure 3 here]

The times devoted to face-to-face conversation, phone, and whatsapp have also been distributed for age and gender, as shown in Tables 5, 6, and 7 for each communication modality.

[Table 5 here]

[Table 6 here]

[Table 7 here]

Below, we present two block diagrams, in Figure 5, which highlight the gender (left) and age (right) differences in the use of the diverse communication channels—face-to-face, phone, and whatsapp. In both cases there appear relevant differences that will be discussed later: male-female different preferences, growing impact of whatsapp in young people, diminished communication of the elderly, etc. One of the many partial results which may be relevant concerns the widow/er condition, which decreases face-to-face conversation almost by half, 224 vs. 125 min/day. See overall results in Figure 5.

[Figure 5 here]

Finally, in the correlation between number of contacts and conversation time, by means of a bivariate analysis and Pearson's linear correlation, we find a coefficient value of 0.12 which is not statistically significant (p-value = 0.055). It means that there is no statistically significant linear relationship between these two aggregate results. However, a number of significant correlations may be found in between the number of contacts of each dimension and the corresponding communication time and the personal satisfaction as well (see table of correlations in the Supplementary Material).

4. Discussion

In this section we discuss first about the number of contacts, then about the conversation times, and finally we approach the different kinds of formal laws that would fit the results obtained.

4.1. Number of contacts

Our results about the total number of contacts noticeably differ from other values in the literature. Although Killworth and Bernard gave estimates close to 300 individuals (Killworth et al., 1990), and Robin Dunbar has given his well-known figure of 150-200 (Dunbar 1996, 2004), we have found an average number of total contacts around 100 individuals. There appear significant differences in between males and females, particularly in the acquaintances domain, and also in between age segments—young males (18-35 years) display a total number of contacts which is above 150 (151.89 putting together family, friends, work/study, and acquaintances in Table 3). In this aspect, given that almost 30% of our sample is old people, the total number of contacts might be an underestimation for general population. In the light of the results obtained, however, one can legitimately ask whether there exists any *significant*

average of total contacts for the general population unrelated to the concrete circumstances of age and gender (plus other factors such as personality type, health condition, occupation, social class, local environment, regional culture, etc.)

Critics of Dunbar's number (Read, 2012; Dezecache, 2012) have often pointed out the lack of empirically well authenticated studies about that figure, as well as the strange 'variance' provided (±50). Given the evident non-Gaussian nature of all the distributions herein obtained, we might put into question the plausibility of such 'variance'—hence, other formal approaches will be explored in the final part of this discussion. Regarding the influence of age segments in the number of contacts, we may observe in Table 3 and Figure 2 the sociotype 'in the making', its temporal evolution along ontogenetic development. How the family, friends, colleagues, and acquaintances' figures evolve along the successive age segments, and how the corresponding sociotype contacts expand, stabilize, and finally tend to collapse. The ontogenetic 'arch' that the sociotype describes along the developmental process of the individual (Berry and De Geest, 2012) looms under our different tables and figures. The diminished social networks around the elderly, particularly for women (who seem to count with around half the number of contacts than the average, as can ostensibly be seen in Table 3), becomes another relevant aspect of our results. This absence of contacts is at the same time a very deep concern in the biomedical literature (Holt-Lunstad, 2017). As is well known, isolation becomes the most important health risk-factor for the elderly (Fowler and Christakis, 2008; Berkman, 2009; Klinenberg, 2012; Cacioppo and Cacioppo, 2014; Holt-Lunstad et al., 2015, 2017). We have already mentioned that in our data the widow/er condition, so common in the elderly, has a dramatic effect on loneliness, decreasing the face-to-face conversation almost by half. That, in general, women appear with fewer contacts deserves a careful sociological discussion, under the gender studies umbrella, that goes beyond the limits of the present work.

Analyzing the partial number of contacts within the family-friends-work/study domains, we can observe that all of them count with a similar number of individuals (around 7-8 in Table 2, and in between 6.5 and 9.9, in Table 3). These figures are in contrast with the multiplicative relationships argued by Dunbar and others (Wald, 2016), in the sense that we should have obtained something like 5, 15, 50, adding to a total of 150 individuals in the four successive social domains or layers we have distinguished (Stiller and Dunbar, 2007). Rather, our results suggest that people tend to establish similar 'familiarity circles' in the closer social domains, where the stable cooperative interactions of their daily life take place. Our figures may be pointing – in the extent to which they are truly representative – to the deep significance of the number 7 in working memory and cognitive abilities (Miller, 1956), now translated to the social sphere. Nevertheless, the definition of the different categories of family-friends-colleagues-acquaintances in the survey, and the way the quantitative questions themselves were formulated, may represent an important influence in the present outcomes. We do think, at least, that these results put into question some widely assumed dogmas and call for further empirical research.

From another angle, about the influence of the new communication technologies, the conservative total number of contacts obtained (Table 2 and Figure 2) contrasts with the facilitated relationships apparently provided by these technologies. See for instance the penetrance of whatsapp in daily life exchanges for young people (Figure 5). As a number of authors have pointed out, the growing loneliness of individuals seems to be one of the paradoxical characteristics of the contemporary hyper-connected societies (Putnam, 2000; Stivers, 2004; Yang and Victor, 2011; Turkley, 2011, 2015). The significance of a minimum of total relationships and the spontaneous compensation between the different relational domains become open research questions, probably relevant to the current mental health problems in a society of increasingly isolated individuals.

Needless to say, the sociological characteristics of our sample and the wider cultural framework of the Spanish population, in particular of the Aragon region (perhaps less 'open' than other regional cultures in Spain), are factors that may contribute to possible biases in the conservative number of contacts we have found.

4.2. Conversation/communication times

Our estimate of the total conversation/communication time, with an average of *220 min*. (3.66 hours) for face-to-face conversation daily, is not far from the results by Mehl et al. (2007) of around 16,000 words per day. Assuming a conservative estimate of 2-2.5 words per second (Yuan et al., 2007), and that talking/listening times are similar, their results represent 12,800-16,000 sec. of conversation, equivalent to *3.55-4.44 hours*, say around 4 hours or *240 min.* per day—so, not too far from our own results. However, looking at the overall results of Table 4 on total communication time, including face-to-face, phone and whatsapp, we find that the total in our sample is near *335 min.* per day, that is to say around $5^{1/2}$ *hours* devoted to communication—and of those, as said, *3.66 hours* are face-to-face.

Is that figure of a total of $5^{1/2}$ hours of communication an overestimation? Possibly. We might argue that conversation/whatsapp/phone times often overlap with each other; that individuals' intuitive estimations probably lump together the sensation of time passed while talking, irrespective of the channel; and moreover, that the self-report procedure we have used is susceptible to a self-delusion systematic bias, in the sense that sociality and conversation are synonym of positive personal qualities to possess. No doubt that direct observation via technological gadgets should provide more reliable results (Pentland, 2014).

Concerning gender, the differences in communication time between male and female are not significant in our aggregate results (Figure 5, left). However, when we consider age,

some significant differences appear (Figure 5, right). And when we consider gender simultaneously with age, there appear further noticeable variations within Tables 5, 6 and 7—for instance, in Table 6, the values of phone family are consistently higher for females of all ages; or in Table 7 the values of whatsapp family, friends, work/study, and acquaintances are far higher for young people. In Table 5, we can also appreciate that the face-to-face values for the elderly are consistently lower for both genders in comparison with the other age segments.

It is important to note the amount of face-to-face conversation that takes place at work/study. In Table 4 it is the highest contributing category, even higher than family. This substantial conversation time accompanying employment has not been sufficiently taken into account by current approaches, neither in its excesses nor in its deficits. However, how the daily dose of labor "sociotype" is fulfilled becomes an intriguing facet to observe in multifarious occupational realms. It should matter in the general design of working positions, in the planning of rest periods, in commercial and public attention, in compensations for solitary jobs, and especially in the transition from work to retirement. In fact, that old people talk around 50% less than other age segments (Tables 5-7, Figure 5) could be attributed first of all to retirement, then to the gradual loss of relatives and friends, and also to the physical decline to engage in outdoor activities related to social interrelationships. The loss of a marital partner implies a substantial effect on loneliness: as we have pointed out, it decreases the face-to-face conversation almost by half (224 vs. 125 minutes/day).

Is there a minimum of conversation, preferably face-to-face, needed for mental wellbeing? The answer, quite probably, should be affirmative, although further circumstances, including the sociotype ontogenetic arch itself, have to be taken into account: age, gender, personality, occupation, local environment, regional or national culture, social conditions, etc. Indeed this very important question deserves a future, careful investigation.

Finally, in the correlation between number of contacts and conversation times, we have found that most of the categories we have distinguished show significant correlations. See Table 1 in Supplementary Material. On the one side, this body of significant correlations may be interpreted as authenticating the consistency of the whole sociotype approach. On the other side, perhaps it is in the exceptions where more interesting details might be found: that the total number of contacts does not correlate with the total time of face-to-face conversation; that the number of acquaintances does not correlate with the corresponding face-to-face conversation time, etc.

4.3. Formal laws approaching the data distributions

Given the non-Gaussian distribution obtained for both the number of social contacts and the communication times, a power law could be considered as the most cogent fit, as is usually claimed in numerous works of the social networks field—see for instance the multidisciplinary compilation by Geoffrey West (2017). These laws would appropriately cover the falling phase of these long-tailed histograms, but would fail in their rising phase. Herein, the Planckian distribution equation (PDE) has been explored as a more suitable fit. The rationale for this approach relates to the intense inner competition for personal attention and for personal memories underlying the social communication phenomena. As Lanham (2006) posits, the "economics of attention" relates to the commodity in shortest supply in the Age of Information: human attention itself. Insensibly, all our contacts and communicative action participate in the general competition for attention. Therefore, taking into account that, theoretically, the PDE was originated in the resolution of the "econophysics" ultraviolet catastrophe (Ji, 2017), it is no wonder that in comparison with the 'incomplete' power law the Planckian law may hold advantageously in multiple self-organizing realms where direct competition dominates: atomic

physics, protein folding, RNA metabolism, enzyme catalysis, T-cell receptor diversity, fMRI records, human decision making, econometrics, human communication, and so on (Ji, 2017).

As we have already argued [1, 4.1], there have been many discussions and hypothesis on the nature of social networks and the different sizes that can be expected, even more taking into account the new communication/bonding varieties around "artificial social networks". Competition for relational bonds, however, is not restricted to the virtual world or to the economic sphere, as is usually considered. We think that the fits we have obtained for the different histograms (Figure 6) are depicting a panorama of scarce cognitive resources and relentless competition for attention time. To reiterate, our social relationships mobilize an "attention economy" with mechanisms similar to our everyday monetary economy and other competitive domains, as already pointed out by H. Simon (Simon, 1971; Lanham, 2006; Gonçalves et al., 2011). This is precisely the sense of the Planckian competitive 'econophysics' or 'selection processes' highlighted by Ji (2017), which is manifest in a number of biological and social phenomena we have already mentioned, including written and spoken language. In general, it represents the degree of organization (and hence of order) of a physical/biological/social system resulting from symmetry-breaking selection events applied to some randomly available (and hence symmetrically distributed) processes. In the case of social bonds, the randomness of initial interactions is progressively selected into the different relational domains of the sociotype. See in Figure 6 how the PDE fit matches the fundamental histograms of number of contacts and face-to-face conversation time.

[Figure 6 here]

This final topic, that puts social networks and human communication within a broader formal context, will be discussed more deeply by the authors in future works.

Limitations of the present study

The main limitation corresponds to the method of data collection, as the self-report technique may induce a considerable bias in the responses. However, the "wisdom of the crowds" (Surowiecki, 2004) may suggest that, counting with a considerable sample size, a plausible result might be obtained.

About the composition of the sample, although it has not yielded strata balanced between genders, the age groups are balanced better. Finally, a considerable sample size has been obtained, close to one and a half thousand participants.

Another important limitation is that the study was reduced to just one country, Spain, and to subjects mostly sharing a regional culture (Aragón). But this inconvenience is hardly evitable in a first exploration, and further multi-country, multicultural studies are envisioned.

5. Concluding comments

Indeed the number of bonding contacts in the different social networks that surround the individual has been extensively discussed in the literature, but the associated conversation exchanges have been rarely focused upon, at least from the quantitative point of view and taking into account their intrinsic interrelationship with the former. In fact, bonds are always made, maintained, and actualized via conversation—almost exclusively. For our 'social brain', conversation itself has become an adaptive necessity, *per se*. Throwing light on that essential but ignored interrelationship between bonds and conversation was the main goal of the present paper.

In actuality, when we put together both phenomena, bonding and conversation, we are contemplating the very nucleus of human sociality. All the further complexity that has emerged in social structures finally depends on specific face-to-face exchanges or their communicative

surrogates in the different realms. In a similar way, some of the aggravated problems of today, at least in a variety of social quarters, seem to respond to highly disturbed social bonding and increasingly isolated individuals. A minimum of contacts and a *minimum daily talking* are a deeply felt human necessity. Indeed far more research is needed to ascertain and quantitatively evaluate that fundamental, adaptive necessity.

Our modern societies have dramatically altered the circumstances and limitations of our relationships. However, cognition seems to represent the main factor limiting the numbers of contacts that an individual can meaningfully maintain—the capacity of our cortical memories and the information processing limitations of our brains. So, although external aids, external memories, and technological appliances can make a difference, there seems to be a relative constancy in our relational needs and capacities. We are caught into the very limits and necessities of our social nature, of our social brain, following the inner competition for resources and interpersonal memories mobilized by our "attention economy".

Returning to the conceptual triad that has inspired the present work: *genotype, phenotype,* and *sociotype*, we may consider that the information flow which basically characterizes the sociotype – conversation – conveys, in its ceaseless interaction with the bonding structures of societies, an elegant vision of the whole bio-social information processing scheme. It means, in other words, the self-consistent percolation networks of communication across multiple scales championed for biological systems decades ago by Michael Conrad (1984, 1996)—to whom this paper is dedicated.

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FIGURES AND TABLES

Table 1

Characteristics of the study participants (n=1,475)

Sex, females (%)	1000 (68.59)
Age, Md (SD)	49.79 (21.47)
Stable relationship (%)	
with partner/married	715 (49.04)
single	408 (27.98)
separate/divorced	75 (5.14)
widow/widower	260 (17.83)
Connivance (%)	
alone	367 (25.17)
partner	379 (25.99)
partner and children	315 (21.6)
other family	251 (17.22)
friends	51 (3.5)
residence	19 (1.3)
Education (%)	
no studies	212 (14.54)
primary	244 (16.74)
high school	227 (15.57)
university	741 (50.82)
Employment (%)	
student	204 (14.09)
unemployed	80 (5.53)
employed	638 (44.06)
retired	407 (28.11)
Salary (%)	
<Minimum wage (MW)	353 (28.58)
1-2 MW	479 (38.79)
2-4 MW	310 (25.1)
>4 MW	93 (7.53)
Social satisfaction *(VAS 0-100)*, Md (SD)	72.45 (21.23)

Note. Md=Mean; SD=Standard Deviation; Number and percentage (%). MW=650€

Table 2

Number of contacts in each sociotype domain, and the total number of contacts.

	Family	Friends	Study/work	Acquaintances	TOTAL
Mean (SD)	7.6 (5.9)	7.6 (9.3)	8,1 (12.5)	81.6 (148.4)	98,4 (149.4)
Median (IR)	6 (6)	5 (7)	5 (7)	30 (90)	50.5 (86)

Figure 1

Graphical representation of the distribution of the total number of contacts for the whole population.

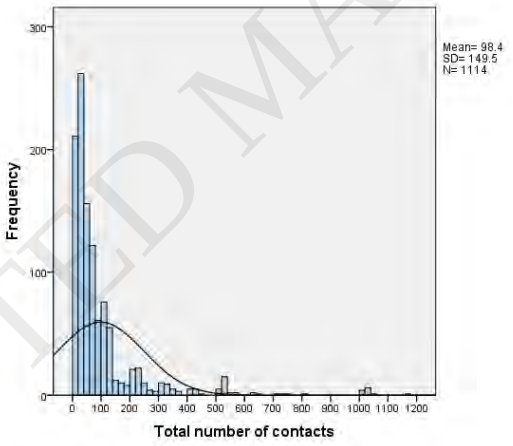


Table 3
Number of individuals for age and gender in each sociotype domain.

	18-35 years		p-value*	36-65 years		p-value*	>65 years		p-value*
	Male	Female		Male	Female		Male	Female	
N Family	6,49 (5,1) 5 (5)	7,5 (5,8) 6 (6)	0,020	8,0 (6,1) 6 (6)	9,0 (6,2) 7 (7)	0,033	7,3 (5,4) 6 (7)	6,7 (5,6) 5 (6)	ns
N Friends	9,9 (11,5) 6 (5)	7,5 (5,8) 6 (6)	0,044	9,3 (13,8) 6 (6)	8,3 (9,1) 6 (6)	ns	7,4 (12,2) 5 (7,8)	4,7 (5,7) 3 (5)	0,043
N Work/Study	7,1 (6,8) 5 (8)	6,5 (10,4) 5 (4)	ns	9,7 (12,6) 6 (9)	9,5 (15,9) 6 (7)	ns	-- --	-- --	--
N Acquaintances	128,4 (218,4) 45 (80)	69,6 (103,1) 30 (57,5)	0,005	114,0 (182,5) 50 (80)	92,7 (157,8) 50 (80)	ns	62,8 (105,9) 20(94)	52,9 (121,0) 10 (43,3)	0,019

Note. *U de Mann-Whitney. Mean (SD) Median (IR) SD=Standard Deviation IR= Interquartile range

Figure 2

Block diagrams that represent the gender differences (left) and age differences (right) in the number of individuals that are integrated in each one of the sociotype dimensions.

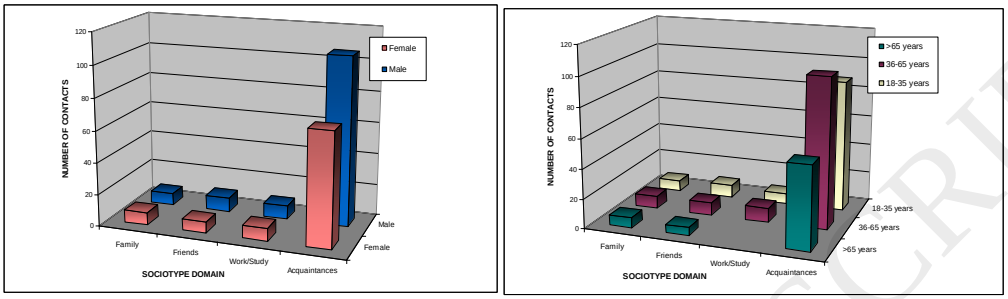


Table 4

Communication time for the different modalities and for each one of the sociotype domains, and totals, all expressed in minutes daily.

		Family	Friends	Study/Work	Acquaintances	TOTAL
Face-to-face	Mean	108.47	22.54	126.9	12.72	219.91
	(SD)	(95.63)	(15.74)	(101.1)	(12.60)	(140.76)
Phone	Mean	25.49	5.03	14.7	2.07	47.19
	(SD)	(36.23)	(9.02)	(30.9)	(4.05)	(48.34)
Whatsapp	Mean	34.59	19.18	26.9	4.65	68.35
	(SD)	(66.05)	(50.53)	(48.2)	(9.67)	(105.40)

Figure 3

Graphical representation of the distribution of the total face-to-face conversation time (left), and technologically mediated communication time [phone + whatsapp] (right), expressed in minutes daily.

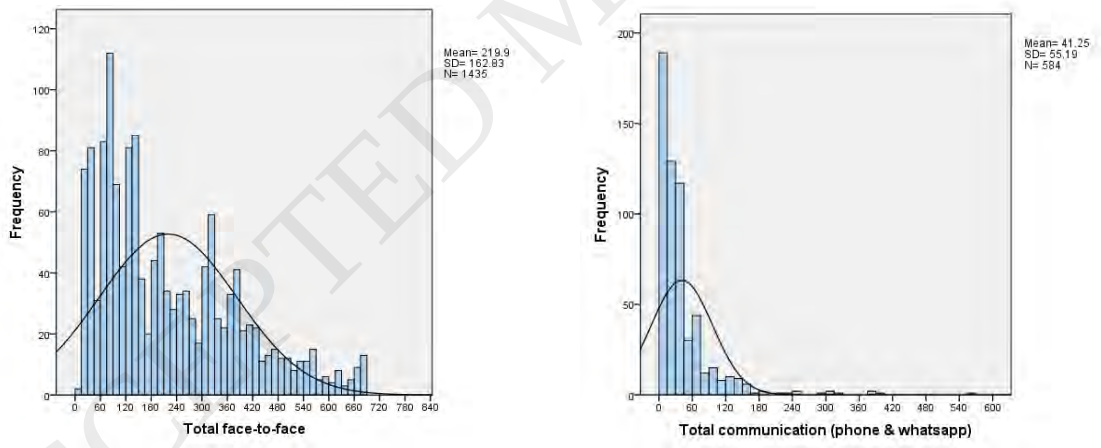


Table 5

Conversation times maintained face-to-face in the different sociotype domains, expressed in minutes daily.

	18-35 years		p-value*	36-65 years		p-value*	>65 years		p-value*
	Male	Female		Male	Female		Male	Female	
Face-to-face Family	109.1 (90.8)	128.2 (99.2)	ns	108,3 (100.3)	114.4 (97.2)	ns	83.4 (87.3)	89.6 (87,5)	ns
Face-to-face Friends	28.2 (14.7)	25.9 (14.7)	ns	18 (15)	20.7 (15.1)	0,03	18.2 (17,2)	22.1 (16.7)	0,027
Face-to-face Work/Study	150.7 (104.0)	136.4 (99.8)	ns	107.7 (94.7)	114.3 (100.9)	ns	--	--	--
Face-to-face Acquaintances	13.2 (12.4)	10.7 (11.1)	ns	12.1 (12.4)	12,3 (12.8)	ns	14.7 (14.1)	14.5 (13.1)	ns

Note. *U de Mann-Whitney. Mean (SD) SD=Standard Deviation

Table 6

Conversation times maintained by telephone in the different sociotype domains, expressed in minutes daily.

	18-35 years		p-value	36-65 years		p-value	>65 years		p-value
	Male	Female		Male	Female		Male	Female	
Phone Family	16.9 (35.7)	31.3 (43.5)	< 0.001	19.6 (32.7)	24.8 (28)	< 0.001	16.3 (15.9)	30.1 (40.5)	< 0.001
Phone Friends	4.5 (9.6)	6.4 (12.4)	0.007	4.0 (6.1)	5.3 (9.7)	0.046	3.0 (4.0)	4.7 (5.8)	0.002
Phone Work/Study	12.3 (27.3)	8.6 (22.1)	ns	21.5 (37.7)	18.6 (35.0)	ns	--	--	--
Phone Acquaintances	1.8 (3.2)	1.4 (4.2)	ns	3.3 (5.0)	2.0 (3.3)	0.019	1.6 (2.8)	2.1 (3.7)	ns

Note. *U de Mann-Whitney. Mean (SD) SD=Standard Deviation

Table 7

Conversation times maintained by whatsapp in the different sociotype domains, expressed in minutes daily.

	18-35 years		p-value **	36-65 years		p-value **	>65 years		p-value **
	Male	Female		Male	Female		Male	Female	
Whatsapp Family	37.52 (73.17)	58.31 (89.84)	< 0.001	15.91 (26.31)	23.36 (41.25)	0.003	11.48 (33.64)	10.78 (21.74)	ns
Whatsapp Friends	26.02 (38.18)	35.84 (81.02)	ns	6.22 (9.88)	8.89 (13.51)	0.001	4.38 (9.21)	4.11 (12.58)	ns
Whatsapp Work/Study	41.54 (56.07)	35.30 (57.13)	ns	11.45 (26.88)	15.87 (33.05)	0.001	--	--	--
Whatsapp Acquaintances	8.18 (13.56)	5.79 (10.95)	ns	3.99 (9.69)	2.93 (4.75)	ns	1.10 (2.57)	1.78 (6.47)	ns

Figure 5
Block diagrams that represent the gender differences (left) and age differences (right) in the communication time devoted to each one of the different communication channels.

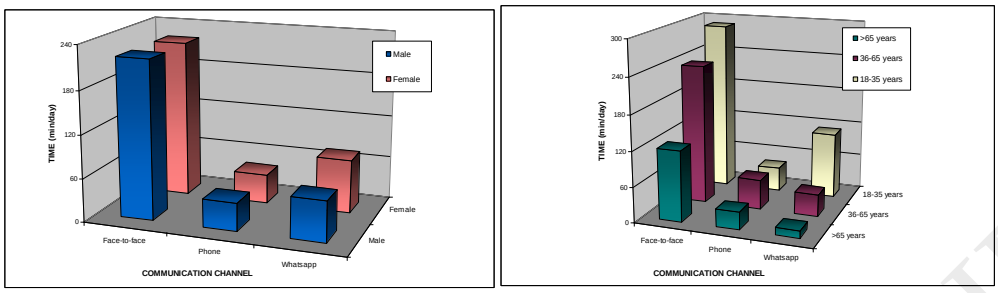
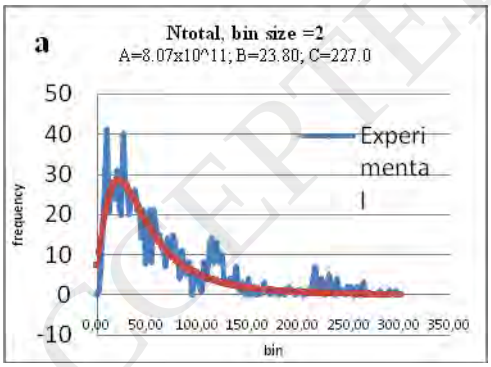


Figure 6
Graphical representation of the Planckian distribution equation (PDE) applied to the number of total contacts (a), and to the total face-to-face conversation time expressed in minutes daily (b). In both cases, the PDE was derived from the Planck's blackbody radiation formula by replacing its universal constants and temperature with three parameters, A, B and C, resulting in y = (A/(x + B)^5)/(Exp(C/(x + B)) -1), where x is the bin number of the histogram under analysis and y is the frequency. The numerical values of the PDE parameters were initially 'guessed' and the best-fitting parameter values were obtained using the Solver program in Excel.

(a) Total number of contacts



(b) Face-to-face conversation