HUMAN TELECOMMUNICATIONS

Background material supporting the proposed establishment of an Institute of Biocommunications within the framework of the Office of Telecommunications

OT/ETS Room 3420
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Ph. 499-1000 Ext 3815
Rough Draft May 8, 1972

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DISCUSSION

IS TELEPATHY POSSIBLE?*

I. M. Kogan

Methods of information theory are used to show that telepathy is not impossible in principle, and that observations and experiments published in the literature are compatible with the concept of an electromagnetic nature for the carrier of telepathic information, identified with the field excited by biocurrents.

The great interest aroused by the remote transmission of thought, or telepathy, is evidenced by the numerous articles, books and newspaper communications [1, 2, 3, 4] devoted to it. The statements made in these sources are often conflicting and are sometimes expressed in a form which is unsatisfactory from a scientific standpoint. Discussions on telepathy are concerned mainly with the conclusiveness of the observations that the supporters of telepathy consider to be a confirmation of its existence. In the present paper the problem is formulated from a different point of view: is telepathy possible in principle? Does it or does it not contradict the laws of nature? And, finally, are the facts observed consistent with the concept of an electromagnetic nature of the field, the carrier of telepathic information? We shall approach this problem by proceeding from the fact that the maximum possible quantity of information that

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can be transmitted per unit time (the system capacity) [5] is

$$C = W \log_2\left(1 + \frac{P_s}{P_n}\right), \text{ bit/sec}, \tag{1}$$

where W is the transmission bandwidth and P_s and P_n are, respectively, the signal and noise powers.

In near-optimum systems (a "biological communication" system may be assumed to have been optimized in the process of a long biological evolution), we have

$$W \approx \frac{1}{\tau}, \tag{2a}$$

$$P_n = \beta W = kTW = \frac{kT}{\tau}, \tag{2b}$$

where τ is the duration of telepathic action, β is the thermal noise spectral density, $k = 1.38 \cdot 10^{-23}$ joules/degree is Boltzmann's constant, and T is the absolute temperature. Hence, expression (1) will take the form

$$C = \frac{1}{\tau} \log_2\left(1 + \frac{P_s \tau}{kT}\right). \tag{3}$$

To ensure a required information-reception rate C*, the power of the signal apprehended by a "receiver" of telepathic information must, from (3), be equal to

$$P_s^* = \frac{kT}{\tau}\left(2^{C^*\tau} - 1\right). \tag{4}$$

By assuming that the carrier of telepathic information is the electromagnetic field excited by biocurrents and that the antennas of "inductor" and "receiver" are provided by the human body, by using the formula of ideal radio transmission (assuming a gain D = 1, matching at the input and negligible propagation losses) we shall determine the order of magnitude of the power P_Σ^* that should be radiated by an inductor of telepathic information

$$P_\Sigma^* = \frac{4\pi r^2 P_s^*}{S_A} = \frac{4\pi r^2 kT}{\tau S_A}\left(2^{C^*\tau} - 1\right), \tag{5}$$

where r is the distance between inductor and receiver, S_A is the antenna effective area, and λ is the wavelength. On the other hand

$$P_\Sigma^* = I^{*2} R_\Sigma = \frac{\pi \eta I^{*2}}{D}\left(\frac{h_e}{\lambda}\right)^2. \tag{6}$$

where R_Σ is the antenna radiation resistance referred to maximum RMS current I^*, $\eta = 120\pi$ ohm, and h_e is the effective antenna height.

By substituting (5) into (6) we find the current I^* satisfying the condition (3) for telepathic information transmission

$$I^* = \frac{r\lambda}{h_e}\sqrt{\frac{kT}{\eta\tau S_A}\left(2^{C^*\tau} - 1\right)}. \tag{7}$$

By taking into account the ohmic loss in the antenna R_A, we have

$$S_A = \frac{\eta h_e^2 \sqrt{R_s^2 + R_A(R_A + 2R_\Sigma)}}{\left[R_s + R_A + \sqrt{R_s^2 + R_A(R_A + 2R_s)}\right]^2}. \tag{8a}$$

In particular cases:
for $R_\Sigma \gg R_A$ (just as in ordinary antennas), by taking (6) into account we obtain

$$S_A = \frac{D\lambda^2}{4\pi}, \tag{8b}$$

and for $R_\Sigma \ll R_A$

$$S_A \approx \frac{\tau A_0}{4R_A}. \tag{8c}$$

It can be seen from (7) that as the telepathic information transmission rate decreases (i.e., as the value of C^* decreases) the required biocurrent amplitude I^* decreases indefinitely.

The values of r, τ and C^* required for practical estimates of the value of I^* should be determined from data of telepathic experiments or observations. To this end, we have analyzed the conditions and results of about 30 observations described in [1] and [2]. Unfortunately, most of them, like the great majority of telepathic experiments, were not designed on a sound scientific basis and were purely empirical; their descriptions did not contain the data required for reliable quantitative estimates. Only four groups of experiments contained a few concrete data on the conditions obtaining. Still, they were sufficiently typical to make it possible to supplement them with some observations very often encountered in everyday life, making in all a set of five typical observations. A brief account and the chief characteristics of these with an indication of the source are given below.

1. ([2], p. 108, Soul, England) "Inductor" and "receiver" (both women) set at a desk facing one another and separated by an opaque partition. The inductor chooses a sequence of Zener cards+ one after another at a rate convenient for the receiver. The receiver without looking at the cards, names the card chosen by the inductor. The number of correct answers in series of repeated experiments considerably exceeds the expected number of correct random guesses.

2. ([2], p. 109, Tischner, Germany, published in 1920). The inductor (a woman) holds in her hands a pair of scissors. The receiver (a woman), who is behind a screen, gradually describes more and more accurately the object in the inductor's hands.

3. ([2], pp. 113-114; Broogmans, Holland, published in 1920 in the USA). The receiver (a man) is in a room, in a light-tight compartment. An aperture made in one of its walls allows the person under test to push his hand out and to indicate with a finger without seeing it one of 48 large squares on a board lying on a table in front of the aperture. The ceiling of the room has a window through which the experimenters (inductors), sitting in a room on the upper floor, can observe the indications of the examinee's (the receiver's) hand. By drawing lots the inductors mentally suggest to the receiver the designation of the square indicated by lots. The percentage of correctly indicated squares in several receivers was 31% and increased to 75% by artificially increasing the excitability of the hemispherical cortex.

4. ([1], pp. 157-159; Bovers, USA, 1958). Sensational experiments involving the transmission of telepathic information from an inductor on land to a receiver in the atomic submarine "Nautilus" 2000 km away are described. Zener cards chosen by the inductor were correctly guessed in more than 70% of the cases. It should be pointed out, however, that the very staging of this experiment makes it of dubious validity.

5. (Numerous every-day observations). Under various not necessarily unusual conditions one person in a group of people says aloud what another has just been thinking or wished to say.

A typical feature of this type of (telepathic) phenomena is the small number of possible issues, i.e., a high a priori probability of the telepathic information transmitted. In combination with a second no less important feature, namely the large reception time of the telepathic signals, this leads to a small value of required information-transmission capacity. In the case of equiprobability of N issues, which is typical of the majority of deliberately staged telepathic experiments, the entropy of the telepathic message is equal to

$$H = \log_2 N, \text{ bit}. \tag{9}$$

The minimum capacity theoretically required in this case is

$$C^* = \frac{\log_2 N}{\tau}, \tag{10}$$

and, by taking (8) into account, expressions (4), (5) and (7) can be rewritten in the form

$$P_B^* = \frac{kT}{\tau}(N-1) = 4.15 \cdot 10^{-21} \frac{N-1}{\tau}. \tag{11a}$$

+Zener cards are a set of five elementary figures clearly distinguishable from one another (a square, a star, a cross, a circle, and wavy lines).

$$P_E^* = \frac{4\pi r^2 kT}{\tau S_A}(N-1) = \frac{5.2\cdot 10^{-20} r^2 (N-1)}{\tau S_A}, \tag{11b}$$

$$I^* = \begin{cases} 3.3\cdot 10^{-12}\dfrac{r}{h_e}\sqrt{\dfrac{4\pi(N-1)}{D\tau}} & (R_E \gg R_A), \quad (11c) \\ 3.3\cdot 10^{-12}\dfrac{r\lambda}{h_e^2}\sqrt{\dfrac{4R_A(N-1)}{\tau}} & (R_E \ll R_A). \quad (11d) \end{cases}$$

It can be seen from relations (11c) and (11d), shown in Fig. 1a and b, that the transmission of telepathic information by the electromagnetic field of biocurrents is possible in principle over any distances, the smaller the information-transmission rate the larger the distance.

To decide whether the above-described observations do actually confirm the existence of telepathy, we need to determine the values of I^* corresponding to them and compare them with realistic values of biocurrents.

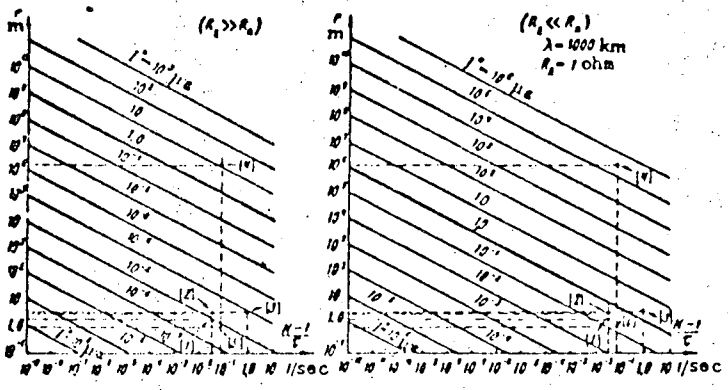

Fig. 1

The initial characteristics required for a quantitative analysis of the above-described observations, and rounded-off results of calculations according to the above formulas for $h_e = 1$ m (approximately half a man's height), are summarized in Tables 1 and 2; the data shown in brackets in Table 1 are not explicitly quoted in the corresponding references and their order of magnitude has been estimated from indirect data. Table 2 also gives estimates of the energy Q and number of quanta n of the received signal carrying the telepathic information, as well as the values of the signal-to-noise ratio P_S/P_n; for comparison we also show values of n in typical sensitive radar receivers (RS), gun-aiming stations (GAS), and radio telescopes (RT).

Table 1

Observ. No.	Initial data			Calculation results				
	N	τ, sec	r, m	H, bit	C^*, bit/sec	P_E^*, w	I^* $(R_E \gg R_A)$, a	P_E/R_A $(R_E \ll R_A)$, w/ohm
1	5	(120)	2	2.32	0.019	10^{-22}	10^{-11}	10^{-22}
2	(15)	720	3	3.92	0.0054	10^{-22}	10^{-11}	10^{-22}
3	48	(60)	4	5.6	0.094	10^{-21}	10^{-10}	10^{-20}
4	5	60	$2\cdot 10^4$	2.32	0.039	10^{-21}	10^{-5}	10^{-10}
5	(5)	(60)	1	2.32	0.039	10^{-21}	10^{-11}	10^{-23}

Tablo 2

Observ. No.	$P_i\lambda^2 (R_i \geq R_A)$, w·m²	$\frac{P}{\lambda\sqrt{R_A}}$ $(R_i < R_A)$, w·m^{-1}·ohm^{-1}	Q, Joules	$\frac{Q}{N}$, Joules	$\frac{n}{\lambda}$, m^{-1}	$\frac{P_s}{P_n}$	n	P (λ = 1000 km, R_A = 10 ohm), w
1	10^{-19}	10^{-13}	$1.2\cdot10^{-20}$	$2.4\cdot10^{-21}$	$0.0\cdot10^{4}$	2.5		10^{-7}
2	10^{-19}	10^{-13}	$7.2\cdot10^{-20}$	$4.8\cdot10^{-21}$	$3.0\cdot10^{6}$	18		10^{-7}
3	10^{-17}	10^{-12}	$6\cdot10^{-19}$	$12.5\cdot10^{-21}$	$3\cdot10^{4}$	150		10^{-6}
4	10^{-7}	10^{-7}	$6\cdot10^{-20}$	$12\cdot10^{-21}$	$3\cdot10^{6}$	15		10^{-1}
5	10^{-19}	10^{-13}	$6\cdot10^{-20}$	$12\cdot10^{-21}$	$3\cdot10^{6}$	15		10^{-7}
RS			10^{-13}		$7\cdot10^{11}$		$2\cdot10^{10}$	
CAS			10^{-14}		$5\cdot10^{10}$		$5\cdot10^{9}$	
RT			10^{-15}		$6\cdot10^{9}$		$2\cdot10^{9}$	

Since the estimates of Table 2 are functions of wavelength, we shall determine the possible range of wavelengths carrying telepathic information. This can be done by making certain assumptions.

a) We may assume that if the power radiated by living organisms exceeded a quantity of the order of 10^{-8}-10^{-10} w, this power would long ago have been detected. Since this has not been the case, we may assume that if these radiations do exist, their power is smaller than 10^{-8}-10^{-10} w. According to Table 2 the corresponding wavelengths are greater than (1-300) m.

b) Bearing in mind that in long-distance telepathic observations (observations of type 4) the oscillations must be capable of bending round the Earth's surface, waves shorter than approximately 10 m must be excluded, thus $\lambda \gtrsim 10$ m.

c) The longer the wavelength the smaller the attenuation undergone by the surface wave. Order-of-magnitude calculations for observation 4 (the most critical in this sense) show that in a sea-water layer (of a thickness of the order of decameters) and in the metal frame of a submarine (of a thickness of the order of centimeters) the attenuation does not exceed approximately 5 db for a wavelength $\lambda > 300$ km.

d) If the source of the electromagnetic field is assumed to be (brain) biocurrents, which have observed frequencies up to 1 kc, we obtain $\lambda \gtrsim 300$ km.

e) The number of quanta, n, corresponding to the received-signal energy Q is

$$n = \frac{Q}{hf} = \frac{Q\lambda}{ch} = 5.04\cdot10^{24}\, Q\lambda, \tag{12}$$

where $h = 6.624\cdot10^{-34}$ joule·sec is Planck's constant.

If it is assumed that the value of n in the reception of telepathic information is of the same order as that of sensitive receivers, i.e., $n \approx 10^{9}$-10^{10} (noise of quantum nature begins to arise for small values of n), then from Table 2 $\lambda \gtrsim 10$ km.

All these estimates, shown diagrammatically in Fig. 2, provide a lower bound for the possible wavelength.

f) Comparison of biocurrents actually possible with the data of Table 2 enables us to assess an upper bound for the wavelengths. Unfortunately, direct experimental biophysical data of this kind are not available. Data exist suggesting that the biocurrents excited by separate nerve cells of the brain have a value of the order of 10^{-9} amp. In mental processes caused by specific stimuli (for example, luminous stimuli), an intense excitation envelops groups of nerve cells comprising 10^{5}-10^{6} cells. Biocurrents connected with the excitation of several cells in a group are not, of course, coherent either in time or space. Nevertheless, the presence of a common stimulant is bound to cause some correlation between the currents of separate cells,

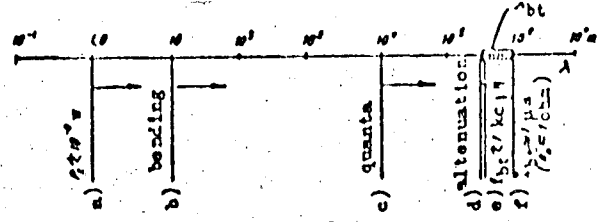

Fig. 2

as a result of which the total "effective" current of a group of cells will be larger than the biocurrent of a separate cell. From data of indirect experiments the biocurrents of groups of cells may be expected to reach values of a few microamperes, i.e., even larger values than the minimum required for the transmission of telepathic information over small distances (observations 1, 2, 3 and 5). Then, from Table 2, an upper wavelength bound is $\lambda \approx 1000$ km, which is compatible with the lower bounds for λ given above (Fig. 2).+

On the strength of this evidence, the facts of telepathic information transmission over small distances (cases 1, 2, 3 and 5, shown in square brackets in Fig. 1b) are attributable to the field of biocurrents with wavelengths of the order of hundreds of kilometers.++

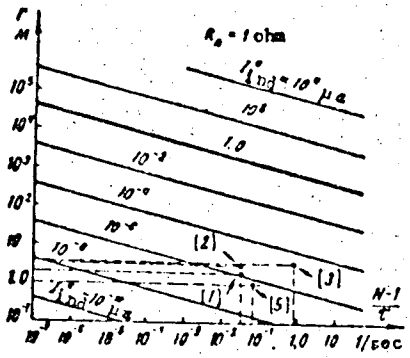

Fig. 3

By bearing in mind that in this wavelength range the predominant contribution at small distances is that of the induction field, by considering the field source as a dipole, and by using the well-known relationship between the radiation-field and magnetostatic-field components of a dipole, we can find the amplitude of biocurrents required for the transmission of telepathic information in the induction region

$$I^*_{ind} = 20.8 \cdot 10^{-12} \left(\frac{r}{h_0}\right)^3 \sqrt{\frac{4R_A(N-1)}{\pi}} \qquad (13)$$

Thus, as can be seen from Fig. 3, the possibility of the existence of telepathy is even more convincing, and the estimated required values of I^*_{ind} are 4–5 orders smaller than the actually possible values of biocurrents ($\sim 1\,\mu a$), the value of I^*_{ind} being independent of frequency.

The physical reality of telepathic communication over large distances (observation 4) is not confirmed by our calculations. It is difficult to say whether this is evidence of the inadequacy of the theory or whether the facts themselves did not occur as reported and are intentional or unpremeditated misinformation.

The inverse dependence of required power (or biocurrent intensity) on the probability of the issue of information gives reasons for assuming that at the lowest more primitive stages of evolution, when the number of issues important for the existence of individuals of a given species is small, while the means of exchanging vitally important information are limited, telepathy may have played a biologically important role. On the other hand, in highly organized organisms (e.g., in man) the biological importance of telepathy cannot be high since the powers (the biocurrents) required for the transmission of the many, low-probability messages required for normal life, would reach unrealistically large values.

+While agreeing with the above estimate of the value of brain biocurrents, various investigators differ in their conception of the biocurrent field configuration, which leads to different estimates of the fields generated by them. In the present paper, on the basis of the existence of a stable macrostructure of the field of biopotentials, the existence of a corresponding field of biocurrents is postulated.

++The matching condition used in deriving formula (8), which implies the compensation of resonance-type reactive impedances is of great importance in this wavelength range. Although there is no direct confirmation of this, the fulfillment of the matching condition is not impossible, since the velocity of propagation, in an organism, of electrical oscillations connected with nervous stimuli, is several orders of magnitude smaller than the free-space velocity of light.

Thus there are reasons for assuming that the existence of telepathy does not contradict the laws of nature, and its carrier could be the electromagnetic field of extra-long waves excited by biocurrents.

Does telepathy actually exist? To answer this convincingly (and to ascertain the concrete mechanism of telepathy) we require well thought out and correctly designed psychological and biophysical experiments based on a sound scientific approach. The ideas developed in this paper may well provide a basis for such an approach.

The author is grateful to all comrades who have discussed the problem with him for many interesting and useful comments.

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REFERENCES

1. B.B. Kazhinskiy, Biological radio communication, AN Ukr SSR, 1962.
2. L.L. Vasil'yev, Mysterious Phenomena of the Human Psycho, GIPL, 1963.
3. A. Kitaygorodskiy, Fruits of enlightenment, Literaturnaya Gazeta 1964, 140 (4882).
4. A. Roshchin, We must not be afraid of facts! Literaturnaya Gazeta, 1964, 140 (4882).
5. C. Shannon, Studies on Information Theory and Cybernetics (transl. from English edited by R.L. Dobrushin and O.B. Lupanov), IL, 1963.
6. S. Manczarski, Nowe możliwości oddziaływania na zmysły i pamięć człowieka, Smypozjum Problemy N woczesnych systemów-teletransmisyjnych. Konferencja dziś i jutzo teletrasnmisij, Polska Akademia Nauk, Warszawa, 4-6, Grudnia, W-10, 1963.