

ORIGINAL PAPER

Quasi-quantum model of potentization

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Analytical time-dependent functions describing the change of the concentration of the solvent $S(t)$ and the homeopathic active substance $A(t)$ during decimal and centesimal dilution are derived. The function $S(t)$ is a special case of the West–Brown–Enquist curve describing ontogenic growth, the increase in concentration of the solvent during potentization resembles the growth of biological systems. It is demonstrated that the macroscopic $S(t)$ function is the ground state solution of the microscopic non-local Horodecki–Feinberg equation for the time-dependent Hulthén potential at the critical screening. In consequence potentization belongs to the class of quasi-quantum phenomena playing an important role both in biological systems and homeopathy. A comparison of the results predicted by the model proposed with the results of experiments on delayed luminescence of a homeopathic medicine is made. *Homeopathy* (2011) 100, 259–263.

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Introduction

Homeopathic medicines are derived from botanical, animal or mineral sources by a successive dilution and vigorously shaking (succussion) referred to as *potentization*. This process converts the original substance into a therapeutically active medicine of decimal (1:10), centesimal (1:100) or quinquaginta millesimal (Q- or LM-potency 1:50 000) dilution scales. The homogenization of active substance involves, for liquids, shaking; insoluble substances are homogenized by grinding (trituration). The dilution attained after one decimal dilution is termed D_1 and is used as the starting point for preparing the next dilution, D_2 in exactly the same manner. This process can be continued indefinitely even beyond Avogadro number, when no molecules of the active substance are present in medicine. To explain activity at high dilutions researchers have used theoretical models which refer to water polymers,¹ clathrates,² electric dipoles,³ vortices⁴ and other^{5–8} mechanisms and structures assumed to be carriers of information transferred from the molecules of the active substance to the ordered molecules of the solvent produced by potentization. According to the

models^{1–8} specified this information is administered during a homeopathic treatment.

A careful reading of the Hahnemann's Organon of Medicine⁹ reveals that he believed in the possibility of exciting in the homeopathic medicine a spirit-like power of medicines (geistartige Kraft der Arzneien) or a vital force by potentization. According to Hahnemann this vital force is immanent component of the homeopathic medicine besides the solvent (water, ethanol, lactose) and active substance employed in its production. It is interesting that the concept of spirit-like power of homeopathic drugs has been abandoned in contemporary homeopathy. The main objective of the present work is to demonstrate that the concentration of the solvent in which the active homeopathic substance is diluted increases according to the function which is a special case of the West–Brown–Enquist curve describing ontogenic growth. Hence, the medicine prepared according to the homeopathic method should be endowed with a power to growth – the same as a growing biological system. I will compare the model proposed with recently performed experiment on delayed luminescence.

Mathematics of potentization

Let's assume that the active substance of mass m_A is dissolved and homogenized in the solvent of mass m_S by making use of the succussion procedure and decimal dilution. In such circumstances at every step of potentization the following relationship is satisfied

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$$m_A + m_S = M \quad (1)$$

in which $M = \text{const}$ is the total mass of the medicine prepared. For example, D_1 and D_2 potencies can be described by the formulae (the unit of mass is grams)

$$D_1 : \frac{1[\text{g}] + 9[\text{g}]}{10} = 0.1[\text{g}] + 0.9[\text{g}] = 1[\text{g}]$$

$$D_2 : \frac{\frac{1[\text{g}] + 9[\text{g}]}{10} + 9[\text{g}]}{10} = 0.01[\text{g}] + 0.99[\text{g}] = 1[\text{g}]$$

In the similar manner one may produce further potencies using both decimal and centesimal dilution. The results are presented in Table 1.

Dividing the mass relation (1) by M one gets

$$A(x) + S(x) = \frac{m_A}{M} + \frac{m_S}{M} = 1 \quad (2)$$

in which $A(x) = m_A/M$ and $S(x) = m_S/M$ multiplied by 100 denote the concentration of the active substance $A(x)$ and solvent $S(x)$ in medicine, $x = 1, 2, 3, \dots, N$ stands for the step of the potentization. The functions $A(x)$ and $S(x)$ can also be interpreted as the probability of finding a molecule of the active substance or a molecule of the solvent in the homeopathic medicine. The results presented in Table 1 show that for the decimal dilution $A(x)$ and $S(x)$ can be specified as

$$A(x) = 10^{-x} \quad S(x) = 1 - 10^{-x} \quad (3)$$

for centesimal dilutions we have

$$A(x) = 100^{-x} = 10^{-2x} \quad S(x) = 1 - 100^{-x} = 1 - 10^{-2x} \quad (4)$$

Potentization time

According to Hahnemann⁹ the potentization (dynamization) of the medicine is obtained by a sequence of succussions and dilutions in a given time sequences, or by an exact number of mixing (triturations) of a diluted medicinal substance. For example, the dispersion and homogenization of the active substance in the liquid solvent usually takes 4 min for mineral substances and 2.5 min for plant substances and animal compounds; the homogenization of solid substances by trituration takes about 1 h per step. Each potentization is performed in a specific time interval. Hence, we can introduce a *potentization time* t_0 , to produce D_{x+1} dilution from the D_x diluted active substance. Mathematically

Table 1 Decimal and centesimal dilutions of the active substance of concentration $A(x)$ and the solvent of concentration $S(x)$ in homeopathic medicine; $x = 1, 2, \dots, N$ denotes the potentization step

D_x	$A(x)$	$S(x)$	C_x	$A(x)$	$S(x)$
D_1	0.1	0.9	C_1	0.01	0.99
D_2	0.01	0.99	C_2	0.0001	0.9999
D_3	0.001	0.999	C_3	0.000001	0.999999
D_n	10^{-n}	$1 - 10^{-n}$	C_n	10^{-2n}	$1 - 10^{-2n}$

the potentization step can be given in the form of the time-dependent function

$$\frac{t}{t_0} = x(t) \quad (5)$$

Now, one may express the x -dependent functions $A(x)$ and $S(x)$ in the time-dependent form

$$A(t) = 10^{-x(t)} = \exp(-at)$$

$$S(t) = 1 - 10^{-x(t)} = 1 - \exp(-at)$$

$$a = \frac{\ln(10)}{t_0} = \frac{2.302585093}{t_0} \quad (6)$$

which describe the decrease of the active substance in the solvent and increase of the solvent concentration in the medicine. Applying the same mathematical procedure for centesimal dilutions one gets the formulae

$$a = \frac{\ln(100)}{t_0} = \frac{4.605170186}{t_0} \quad (7)$$

The functions $A(t)$ and $S(t)$ determine the concentration of the active substance and the solvent in the medicine at the each step of the potentization procedure performed at the time t_0 including succussion and dilution. They accurately reproduce the experimental data points presented in Table 1 for $t = nt_0$, $n = 1, 2, \dots$, whereas the periods $<0, t_0>$, $<t_0, 2t_0>$ etc. are only approximations to the true curves describing the concentration of the active substance.

First- and second-order dynamization

The function $S(t)$ describing the increase in the solvent concentration during potentization satisfies the first- and second-order differential equations

$$\frac{d}{dt} S(t) - a \frac{\exp(-at)}{1 - \exp(-at)} S(t) = 0 \quad (8)$$

$$\frac{d^2}{dt^2} S(t) + a^2 \frac{\exp(-at)}{1 - \exp(-at)} S(t) = 0 \quad (9)$$

The second term in the above equations represents the well-known in the quantum physics Hulthén potential¹² widely used in the description of electrostatic interactions between micro-particles. The equation (9) can be expressed in the dimensionless coordinate $\tau = at$

$$\frac{d^2}{d\tau^2} S(\tau) + \frac{\exp(-\tau)}{1 - \exp(-\tau)} S(\tau) = 0 \quad (10)$$

One may prove that the above equation is a special case of the quantal non-local Horodecki–Feinberg equation^{10,11} for the time-dependent Hulthén potential¹² at the *critical screening*¹³ (see Technical appendix). This result indicates that the process of increasing concentration of the solvent during preparation of the homeopathic

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