About the Neurobiological Foundations of the *De-Qi* — Stimulus-Response Relation

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Abstract: In acupunctural reflexotherapy, it is usually stated that no appreciable therapeutic effect is obtained under a certain stimulation level, which is determined by the appearance of a particular sensation known as *De-Qi*. Given that afference control actions of the central nervous system do not work in this way, but rather adapt, with some peculiarities, to a classical schedule of proportionality between stimulus and response, our aim is to evaluate the extent to which acupunctural stimuli of increasing intensity can also increasingly modify neurophysiological parameters, by focusing on quantification of metamerigic levels, by an F-wave study and by means of somatosensorial evoked potential in the telencephalus. Twenty-one healthy volunteers were studied; values corresponding to the parameters indicated in a basal situation were taken and both a non-acupunctural point and the classical 4IG point were punctured simply, until the *De-Qi* sensation was obtained, following which, electrical stimulation was applied. Clear progressiveness was observed in the modifications of both the F-value and somesthesic potential values with increasing stimuli. It is true that the main inflexion occurs where obtaining *De-Qi*, but when overstimulation is applied from that time, greater variations take place, which is particularly patent in the case of somesthesic potential latency. Furthermore, the puncture of an extrachannel point shows that the mere puncturing of the skin does not produce any of the aforementioned effects. Despite the classical postulates, it is observed that, the greater the intensity of the acupunctural stimulus, the greater the modifications in the neurophysiological parameters studied. Control of somesthesic afference by acupuncture has already been demonstrated and quantified; now, however, the direct relation between the intensity of this effect and that of the stimulus used to produce it, which is quite far removed from the classical energetic conceptions, is also observed. The effect of acupunctural stimulation

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is closely related to the intensity of the stimulus applied and the De-Qi sensation is not required to obtain neurofunctional modifications and stimulations that go beyond it producing greater effects.

**Keywords:** Neuroreflexotherapy; Acupuncture; F-Response; Somatosensorial Evoked Potential; De-Qi.

**Introduction**

An outstanding phenomenon in traditional acupunctural practice is obtaining the sensation, known as De-Qi, which is perceptible by both the patient and the therapist. This is a complex sensation of discomfort-weight-electrical discharge-deep adhesion. It is difficult to express in words, but is unmistakably identifiable (Liao, 1999). The most traditional schools of acupuncture consider that De-Qi is a *sine qua non* condition for obtaining a therapeutic effect (Nguyen, 2000), while more modern practitioners claim that a mere puncture produces an appropriate effect on the imbalance to be treated. Some experimental data demonstrate functional effects that can be correlated with the perception of De-Qi, obtained by means of different needling techniques (Lin, 1997; Roth, 1997; Zhang, 1998), which are reflected in changes of skin resistance (Kimura *et al.*, 1992; Ryan, 1999), modification of different evoked potential parameters (Hsieh *et al.*, 1998; Wei *et al.*, 2000), increases in the cortisone serum level (Roth *et al.*, 1997) or remotes functional modifications (Xing and Li, 1998). In any event, we find ourselves talking in terms of energy, of rebalancing, which are not compatible with the neurobiology upon which our medical practice and our physiological and physiopathological conceptions are based.

This work is based on previous findings made by our group. The action of both metameric (Abad-Alegría and Bono, 1988; Melendo and Abad-Alegría, 1991; Abad-Alegría and Bono, 1992) and central (Abad-Alegría and Galve, 1993; Abad-Alegría *et al.*, 1995a and 1996) acupunctural stimulus has been demonstrated by neurophysiological methods, which are corroborated by the few external studies published on the same subjects (Yamauchi *et al.*, 1976; Hsieh, 1998; Wei *et al.*, 2000; Bossi *et al.*, 1984; Knardhal *et al.*, 1998). The purpose of this research, carried out in the field of simple somesthesia, is to find out whether De-Qi has any objective neurological correlate. If stimuli of sufficient intensity to produce the sensation, whether stimuli of more than sufficient intensity can produce perceptible and different effects. We are attempting to establish whether there is a sort of all-or-nothing law in punctual activation, which determines that, below the stimulus level which produces the De-Qi sensation, no appreciable effect is obtained. Moreover, that the additional stimulus does not increase the effect obtained after the traditional perception. In other words, we would like to determine whether, in acupuncture, the greater the sensorial afferent influx, the greater the response (within specific limits and with functions that are not necessarily linear), or whether the process works in some exceptional neurobiological way.
Subjects and Methods

The study was carried out on 21 healthy volunteers, 13 of whom were men and eight women, aged between 19 and 23 years. In the case of the women, the experiments were performed outside the catamenial period, leaving three days on either side, with the aim of avoiding possible hormonal interferences in the process (Orós et al., 1986). The following values were obtained: the number of different F-units recorded in 1 minute, the total number of F-discharges in one minute, peak N1 latency of the somatosensory potential obtained by stimulus of the median nerve and N1-P1 width of the same potential, in accordance with criteria to be described below, in independent sessions and in the following situations: (1) basal, prior to any needling; (2) one minute after simple puncture on Hoku-4IG using a 4 cm-long disposable, sterile, stainless steel needle (the location is checked by means of conventional maps and an acupunctoscope); (3) after traditional puncturing on the same point with needling until the De-Qi sensation is clearly obtained; (4) after having obtained the sensation, with the application of additional stimulus by means of electric impulses of maximum tolerable intensity (0.2 ms square waves, usually at 4–6 Ma, with a stimulus frequency of 10 Hz) for 10 minutes; and (5) one minute following simple puncturing on an extra-acupunctural point (situated on the external edge of the thenar eminence; activity is checked in this case, not only by the channel map, but also by the absence of response with electric acupunctoscope). Extrachannel puncture makes it possible to rule out any effect of mere puncture in an area of the organism on the neurophysiological parameters being evaluated.

The number of different response F-units obtained and the total discharge frequency of these units on the opponens pollicis were determined by means of surface electrodes, following stimulation of the median nerve, with the usual clinical procedures (Delisa et al., 1994); the analysis time was 100 ms, stimulation took place at 0.5 Hz with supramaximal square wave stimuli of 0.2 ms and 20 responses were analyzed (gain of 500 µV per division and 20–3000 Hz pass band), in accordance with already established exploratory criteria for the evaluation of medullar segmental activity (Abad-Alegría, 1981 and 1984; Pradham, 1998; Espiritu et al., 2003) to determine the activation of the interneuronal metamer system of the anterior horn of the spinal chord. The somatosensory evoked potential of the median nerve in the central cortex collateral to the stimulus and the production of the signal in the somesthetic cortex, were also obtained (Halliday, 1993), taking the signal obtained from the average of 100 steps, with an analysis time of 50 ms, 10 µV sensitivity per division and 1–1000 Hz pass band, stimulated at the lowest intensity (waves of 0.2 ms duration) that produced a clear opponens muscle movement. The data obtained were compared using Student’s t test for paired data and differences of P < 0.05 were considered significant.

Results

Table 1 is a synthesis of the data obtained in the different conditions of the experiment. It is observed that significant changes in the parameters studied do not take place in any of the
cases when puncture is made outside the acupunctural area. The number of different F-responses is not significantly modified when De-Qi is obtained, but it does decrease clearly when an additional electric stimulus is applied on the previous phase. As for the F-discharge frequency per minute, a questionable modification, which is on the verge of being significant, is detected with De-Qi, while the decrease in value is now clearly demonstrable when the amount of stimulation is increased. The range of somatosensory potential is modified very early; mere puncture on 4IG already produces a decrease in the value, which increases

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Basal</th>
<th>Non-Acupuncture Point Puncture</th>
<th>Ho-Ku Simple Puncture</th>
<th>Ho-Ku Puncture with De-Qi</th>
<th>Ho-Ku Puncture with De-Qi and Over-stimulus</th>
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</thead>
<tbody>
<tr>
<td>F response (total nr.)</td>
<td>2.4 ± 0.5</td>
<td>2.3 ± 0.7 (P = 0.687)</td>
<td>2.3 ± 0.5 (P = 0.341)</td>
<td>2.3 ± 0.5 (P = 0.432)</td>
<td>1.9 ± 1.1 (P = 0.032)</td>
</tr>
<tr>
<td>F different units (by minute)</td>
<td>28.0 ± 3.8</td>
<td>27.3 ± 4.0 (P = 0.750)</td>
<td>26.8 ± 3.1 (P = 0.060)</td>
<td>27.5 ± 2.8 (P = 0.053)</td>
<td>21.3 ± 7.5 (P = 0.043)</td>
</tr>
<tr>
<td>SSEP amplitude (µV)</td>
<td>14.2 ± 4.7</td>
<td>14.3 ± 5.3 (P = 0.871)</td>
<td>12.2 ± 5.5 (P = 0.018)</td>
<td>11.1 ± 6.3 (P = 0.002)</td>
<td>11.9 ± 4.6 (P = 0.002)</td>
</tr>
<tr>
<td>N1 latency SSEP (ms)</td>
<td>19.4 ± 0.8</td>
<td>19.6 ± 0.9 (P = 0.901)</td>
<td>19.3 ± 1.2 (P = 0.795)</td>
<td>19.3 ± 1.1 (P = 0.816)</td>
<td>23.8 ± 0.5 (P = 0.050)</td>
</tr>
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*: Significant with respect to basal value.

Figure 1. Mean percent values representation, with respect to the basal values, in the different steps of the experiment.
progressively when stimulus is added and until De-Qi is reached or exceeded. The N1 latency of the same potential, however, is only modified significantly, and by a small amount, when a prolonged stimulus is maintained on the previously obtained De-Qi. Figure 1 explains graphically how the progressive application of stimulus on point 4IG, which is presumably the generator of action, also has progressive effects. However, these are clearly unequal depending on the parameter studied and there is a continuous but specific effect for each of them.

Discussion

When it comes to considering the differences in action that are demonstrated with the different stimulus intensities, the first thing the experimenter wonders is whether or not De-Qi really does have a definable neurological basis. Classical statements on what it entails do not enable a positive, fruitful analysis to be made. Furthermore, mere puncture is in itself a means of stimulation, the occasional effectiveness of which has been verified by the classics and gave rise to the concept of hidden arrival of Qi (Tian, 1999), which would seem to be of some importance in the context of the findings of the present study. Recently, a recompilation study of experiments on De-Qi (Chen, 2002) has been published and which entitles the synthesis work carried out as proof of the power and arousal of Chi. In this work, a set of sensations that supposedly demonstrate the arousal of Qi is listed: propagation of the sensation through the acupuncture channel, different sensations for different points and channels, sensation of the passage of Qi in the channel connection, differentiated sensation for the stimulation of two points of a single channel, etc. In any event, although sensation systematization studies are to be found, none of them provides real evidence that a measurable energetic process is in fact occurring. Sensation and action mechanisms are radically different concepts. In this regard, it should be added that some acupuncture-based, but not strictly acupuncture techniques (ATA — acupuncture treatment area), such as puncture on the point of maximum pain, on periarticular points or remote reflex areas, may provide appreciable therapeutic effects, without the existence of any energetic basis or communication channels (Campbell, 1999).

Some elementary anatomical considerations can be made regarding the real basis of the accumulation of effects in proportion to the intensity of stimulation. The structural unit formed by the acupuncture, which, conceptually speaking, is not merely a surface area, but rather a locus with depth and width (Lin, 1997; Plummer, 1980), is related to the sensitive innervation of the structures involved (Bossy, 1984). In other words, the proportion of tendinous, periostic, perivascular, muscular, subdermic (Langevin et al., 2001; Langevin and Yandow, 2002), dermic, painful or free receptor sites is different for the different acupoints; the excitation threshold of the receptors involved is different and the afferences generated involve a particular projection at telencephalic levels so that a different thalamic and cortical representation will be linked to proportionally differentiated afferences for the different sensitivities picked up in relation to each point stimulated and to the depth, duration and intensity of the stimulus (Cao et al., 1997). To achieve the effect, acupuncture afferences
must reach the central nervous system, which is not a new observation in experimental animal lesions and serious medullar injuries (Weng, 1962). Overall, the pathways involved (Snell, 1999) might be as follows: visceral afferences project mainly through the ascending periependimary, reaching the tuber nuclei and the posterior hypothalamus nucleus, from where they project towards the medial and dorsomedial thalamus nuclei, and from there to cortical structures. The painful afferences project through the spinothalamic tract, making an exchange in the thalamic nuclei and from there to the cortex nucleus. Propioceptive afferences ascend mainly through the medial lemniscus to the thalamus nuclei, and then to the cerebral cortex. As can be seen, the interaction of all these afferences is modulated at high levels of the thalamus and also reaches the cortex, so that secondary efferent responses can be easily modulated gradually or in accumulated manner, to the extent that different proportions of the types of afference generate differentiated, progressive stimuli in relation to their respective excitation threshold. Stimulation of endorphin and endocannabinoid secretion as a response to basic diencephalic activation secondary to acupunctural stimulation (Liao et al., 1994) and to the harmful signals that are rapidly generated in local tissue destruction in the form of kinins and analogous compounds (the amount of which will also be linked to the intensity or duration of the stimulation process the response) (Kimura et al., 1992) are other effects that are well known and were demonstrated decades ago.

In conclusion, it would appear that in somesthesia, there is a clear relation between the intensity of the acupunctural neuroreflex stimulus and the response obtained, according to the ordinary laws of biology (Ulett et al., 1998; Fu, 2000). The emphasis placed on De-Qi in classical acupuncture is probably based on the need to objectivate punctural sufficiency, so that sufficient puncture to expel the illness is perceived noticeably, and the former lack of an objective measurement system of the stimulus. There is a world of difference between this and the assumption that biological laws make an exception or a parenthesis in acupuncture; acupunctural neuroreflexotherapy is useful and is clearly therapeutic, but it works out of necessity through the channels of positive biology, without the interference of energetic conceptions that are foreign to experimental deductive thought.

References

NEUROREFLEX CONTROL QUANTIFICATION


