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Canonical Relations of Sensomotoric Reactions to Light and Sound Stimulus

Miroslav Dodig
Independent researcher
University of Rijeka, Croatia
dodig@pfri.hr

ABSTRACT

The sample subjects for this research list 20 subjects, of male gender, ranging from 20 to 22 years of age, a research of sensomotor reactions of multilateral and unilateral body parts was conducted. The process of collecting data and setting parameters was conducted using an instrument called the KINESIOMETER (M. Dodig, 1987), hooked up to an electronic computer, with an adequate periphery, with application of program support for analogue – digital conversion in the programming language SIMON'S BASIC. The basic reason for variability and covariability within the reaction time to light and sound signal incurred as the answer to efficient functioning of the perceptive system, channel permeability, efficiency of data decoding device and efficiency of data transmission and the efficient functioning of commissural connections between hemispheres represents the basic reason for obtained results. The obtained result incurred as the answer to a joint mechanism for structuring and speed of transmission impulse through afferent and efferent channels. In addition, the sensomotor reaction of multilateral parts to light and sound stimulus, due to its own preference of lateralization which manifest itself through curving of space towards the upper limbs, probably incurred as the answer to a larger direct autonomous and automatic use of the channels capacities and high-level organization of active effectors.

Keywords: canonical relations, sensomotor reactions, multilateral body parts, light and sound stimulus.

INTRODUCTION

In the realization of motor motion a broad range of activating various factors is integrated, where sensomotor reactions play a significant role. Sensomotor reactions present an indicator of the state of which an organism in in before, during, and after a reaction [6], [8], [12], [15]. Every sensomotor reaction of an organism in a certain time starts with one receptor reaction and ends with a muscle response. This fact partly determines the course, circumference and rate of success of a unit in interaction with the outside world. The reaction of the organism is caused by the action of a certain stimulus on sensory receptors. Transference of that stimulus to the effector which reacts to the stimulus, represents the reaction time, which is defined as a temporal interval between the appearance of the stimulus and the first sign of a response [5], [7], [9], [13], [14]. In the regulation of the sensomotor reactions of multilateral body parts to light and sound stimulus, an very broad-spectre integration of including various regulative mechanisms is carried out, thus presenting a prerequisite of execution and determining the phenomenon of sensomotor reactions. As the basic communication and interaction is conducted between cerebral hemispheres characterized by a certain amount of autonomy and relative specialization, it is possible to differentiate them according to the types of data they convey, the pace they convey it at, as well as according to the precision of the conveyed data [1], [2], [3], [11].

The set research proceeds from the assumption that in presenting certain stimuli for sensomotor reactions to light and sound stimulus, it is possible to ensure the analysis of said data with one hemisphere (left or right), that is with both hemispheres simultaneously. All the while, depending on the complexity of the task, attempting to determine i.e. compare what analysis is more effective. It is presumed that a simple task requires one hemisphere for data analysis, considering that we “force” both hemispheres to activate themselves when dealing with a multilateral presentation, a relative efficiency of bilateral presentation stimulus is expected. On the other hand, in regard to multilateral motion, both hemispheres must be involved in solving the problem, and this collaboration with a bilateral presentation makes it easier. Since sensomotor reactions of multilateral body parts represent the source of a part of joint variability on light and sound stimulus, this research study was conducted to affirm the relations of these fields. Considering that the morphological – functional structure establishes a dependency of sensomotor reactions, this research study was developed with the aim to affirm a part of the entire variability separated by sensomotor reactions of multilateral body parts to light and sound stimulus.

METHODS

The sample subjects for this research list 20 subjects, male, ranging from 20 to 22 years of age. The planned sample ensures a reliability factor of 0.95, that every correlational coefficient is equal to or larger than 0.42, considers different from zero. The process of collecting data and setting parameters was conducted using an instrument called the KINESIOMETER (M. Dodig, 1987), hooked up to an electronic computer, with an adequate periphery, with application of program support for analogue – digital conversion in the programming language SIMON'S BASIC. The instrumentarium uses 8 important analogue – digital converters (ADC) to which the kinesiometer and signal system were directly plugged into and synchronized with the measuring system.

Measuring is carried out through a determined program. The subject is in an adequate position with an attached instrumentarium and exerts a certain reaction through motion. The kinesiometer latched to body joints ensured transference of analogue sizes of body part reactions, which transform from electrical signals to digital impulses via an analogue-digital converter. The signal light system is directly connected to the converter which is synchronized with the measurement system that has a maximum precision measurement of 2^{-8}, i.e. 256 parts of basic value. In this way obtaining significant data about Sensomotoric reactions to light and sound stimulus of individual body parts simultaneously is made possible. Measuring is carried out via an applied system for measuring in certain positions with solving certain tasks:

(1) The subject is set on a background in a lying position on his back, with spread legs and arms next to his body to which kinesiometers are attached,

(2) On a certain signal (light or sound) the subject exerts motion (flexion and extension – contractions and extending) of arms and legs simultaneously (Figure 1).

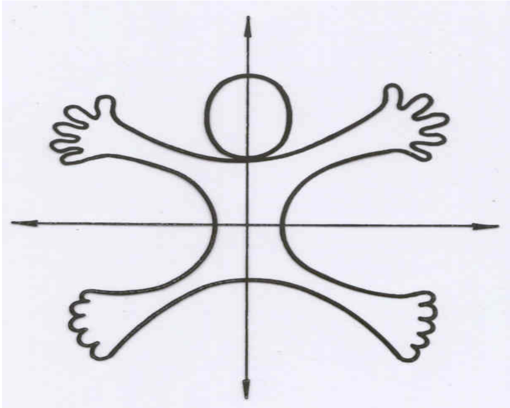

Figure 1. Schematic overview of determinateness of sensomotor reactions of multilateral (D. Ruka, L. Ruka, D. Noga, L. Noga) body parts to light and sound stimulus.

In this way variable groups are isolated which were previously data carriers about Sensomotoric reactions to multilateral body parts on light and sound stimulus. Tests marked with distinct codes where the first letter marks the sensomotor space (S), the second letter marks the type of stimulus, light (S) or sound (Z), the third and fourth letter the body part by which the reaction is realized, left leg (NL), left arm (RL), right leg (ND), right arm (RD) and the sixth letter marks the measured object, multilaterally (M)

(1) Variables for evaluation of sensomotor reactions multilateral (simultaneous reaction for all body parts – left leg, left arm, right leg, and right arm) body parts on light stimulus: 1. (SSNLM), 2. (SSRLM), 3. (SSNDM), 4. (SSRDM)

(2) Variables for evaluation of sensomotor reactions multilateral (simultaneous reaction for all body parts - left leg, left arm, right leg, and right arm) body parts on sound stimulus: 1. (SZNLM), 2. (SZRLM), 3. (SZNDM), 4. (SZRDM)

The relations between sensomotor reactions of multilateral body parts to light and sound stimulus have been analysed by the technique of canonical correlational analysis. For identifying significant canonical dimensions, in addition to the transformational coefficient vector, correlational variable and canonical dimension vectors were also used. The standards of those vectors were treated as a circumference measure for certain canonical dimensions. The number of significant dimensions is determined with the Bartlett method, where all connected canonicalical correlations different than zero with a reliability factor of 0.95 were considered significant. A canonical correlational analysis (Cooley i Lohnes, 1971) was conducted in terms of analysing data for affirming relations between the sensomotor reactions of multilateral body parts to light and sound stimulus. Coefficients of canonical correlation, vectors of transformational coefficients and correlations between variables and canonical dimensions isolated from both groups were analysed. The significance of the coefficient of canonical analysis was tested with Bartlett's method (Bartlett, 1947), with a 0.05 margin of error.

RESULTS

Characteristics of variables were determined via routine descriptive procedures. The results were presented as per the requirements of the data. The interpretation was carried out according to stated spaces displayed in the tables. A group of variables of multilateral body parts to light and sound stimulus (table 1), indicates that all magnitudes of central and dispersive parameters do not vary significantly from the normal distribution.

Table 1. Central and dispersive parameters of sensomotor reactions of multilateral body parts to light and sound stimulus

Variables:	XA	SIG	MIN	MAX
1. SSNLM	0.2842	0.0419	0.1918	0.3495
2. SSRLM	0.2995	0.0407	0.2383	0.4065
3. SSNDM	0.2807	0.0472	0.2172	0.3775
4. SSRDM	0.2564	0.0487	0.1589	0.3364
5. SZNLM	0.3298	0.0669	0.2383	0.4916
6. SZRLM	0.3322	0.0733	0.1934	0.5022
7. SZNDM	0.3233	0.0756	0.2102	0.4613
8. SZRDM	0.2965	0.0696	0.1496	0.4345

Key: SSNLM – sensomotor reaction to light left leg multilaterally, SSRLM – sensomotor reaction to light left arm multilaterally, SSNDM – sensomotor reaction to light right leg multilaterally, SSRDM – sensomotor reaction to light right arm multilaterally, SZNLM – sensomotor reaction to sound left leg multilaterally, SZRLM – sensomotor reaction to sound left arm multilaterally, SZNDM – sensomotor reaction to sound right leg multilaterally, SZRDM – sensomotor reaction to sound right arm multilaterally,
XA – arithmetic mean
SIG – standard deviation
MIN – minimum
MAX – maximum

The obtained results were presented as per the analysis' requirements. First the matrix was analysed, containing intercorrelations of variables in analysed groups (table 2). The basic characteristics of the inter-correlational original variables' matrix are as follows:

- all mutual connections within the variable group that measured reactions of multilateral parts to light and sound stimulus are considerably large, and that particularly refers to the SZRDM variable, which measured the sensomotor reaction to the sound stimulus – right arm.
- Substantially higher mutual connections exist within variable groups that measured the reaction of multilateral body parts to light stimulus, and somewhat weaker yet high in the variable group that measured reactions of multilateral parts to sound stimulus.

Inspecting the inter-correlation matrix, a perception is obtained of a partially morphological determination of obtained connections rotated in the direction of diagonal structures (right arm – left leg). This indicates towards a significantly larger cohesion within the context of morphological determination than towards the type of stimulus.

Table 2. The matrix of correlational coefficients of velocity of multilateral body parts in relation to light and sound stimulus

VARIABLES	1	2	3	4	5	6	7	8
1. SSNLM	1.00							
2. SSRLM	.71	1.00						
3. SSNDM	.71	.54	1.00					
4. SSRDM	.67	.84	.58	1.00				
5. SZNLM	.20	.37	.49	.34	1.00			
6. SZRLM	.69	.73	.42	.66	.37	1.00		
7. SZNDM	.33	.41	.74	.42	.91	.45	1.00	
8. SZRDM	.53	.68	.53	.75	.69	.85	.72	1.00

Key (see Table 1)

It is significant to emphasize that a process which begins as light affects any given receptor (twigs and skittles) thus coming to highly complex processes which decompose photo-chemistry substance that impacts the membrane of the outer receptor segment, thus creating receptor potential (signal hyperpolarisation). Its size is tantamount to the logarithm of light energy as opposed to other transformations that tend to be linear. Ganglionic cells continuously convey signals through optic nerve fibres to the brain in the form of action potential. Optic fibres re-plug within the corpus geniculatum laterale, from where they proceed as geniculocalcarine fibres through optic radiation or the geniculocalcarine tract to the primary optic shell in the carcarial area of the occipital lobe. The fibres of the optic nerve leave towards other cerebral areas (the suprachiasmatic nucleus, motor nucleus of the cerebral trunk, the hypothalamus, pretectal nucleus, upper colliculus, pulvinal, the thalamus area and the cerebral trunk).

The acoustic sensitivity is the basis of the sound perception as motivated by the mechanical vibration that transfers to the eardrum via airwaves and to endolymph fluid labyrinth through sound pits, and across it to sensory cells (Organ of Corti) situated in the cochlea, where mechanical vibrations are transformed into nervous excitement. Nervous excitement is carried out as a series of electrical impulses in one branch of the sound nerve into the elongated marrow, and from there through relay centres into the thalamus in the main auditory centres, which are located in the temple region of the cerebral cortex.

Starting out from the realization that the sensory receptor receives stimulus and conveys data in a minimal time interval between sequential answers, only a part of that time goes towards refractor time in central processes. That part of time is spent by the operator on deciding and organizing answers, which will immediately upon installing an adequate network be carried out without further participation of the willing operation. Actually, from the moment the answer is initiated, the operator can no longer stop it. The efficiency of that reaction time, or rather, the time of initiating an answer, is such that the time lag that significantly contributes towards the duration of creating an efferent signal and its transference to the effector is logged in the system. Thus, it is rational that these processes make up the basics for obtaining canonical correlation where the biggest contributor is the multilateral sensomotor reaction (the reaction of all parts combined). The stated process of transmission of impulse through afferent and efferent channels represents the functional basis for obtaining correlative relations within the space of sensomotor reactions.

Taken as a whole, the obtained results confirm the expected assumptions. That which in a way surprises are the low coefficients within the variable groups of multilateral body parts' reactions to sound stimulus. However, satisfactory and significant cohesion is noticeable within the variable group of multilateral body parts' reactions to light stimulus, and partly between two groups of treated variables. Significant cohesion within the group of multivariant body parts probably incurred as a result of simultaneous reactions of all default parts and mutual cerebral processes. The connection between the two stated spaces probably incurred as a result of the coherence process of separate and cooperative functions of cerebral hemispheres, which can produce multivariant reactions and clearly differentiated reactions. The results indicate that initiating stimulus for individual body segments, undoubtedly indicate the significance of clear preference of the lateralization of hemispheres. In addition, a larger, more direct, autonomous and automatic opportunity of utilizing the capacity of the canal is present, along with high efficacy of active effectors (what is provoked by completing the task with the presented right lateral structures). That incurred as the result of a life of right-handedness.

The cohesion between sensomotor reactions of multilateral body parts to light and sound stimulus is satisfactory. Sensomotor reactions of multilateral body parts towards light and sound stimulus can be explained by canonical relations with two canonical roots (table 3). The first canonical variable exhausts a considerably larger quantity of co-variabilities of analysed variable groups. The cohesion of the first latent variable of (0.96) which explains 92.20 % of the variance of corresponding latent structures. A significant connection was affirmed at the P=0.00 level. The second canonical correlation that belongs to the second canonical factor has a somewhat lesser cohesion (0.79) with 62 % joint variance, at the level of significance P = 0.00.

Table 3. Canon correlations, roots of the canonical equation and significance tests of canonical roots within the space of multilateral body parts at the light and sound stimulus

	C2	C	L	X2	DF	P
1	.9220	.9602	.0129	63.079	16	.0000
2	.6156	.7846	.1653	26.097	9	.0020
3	.5276	.7264	.4301	12.234	4	.1157
4	.0895	.2992	.9105	1.360	1	.2435

Key C2 – eigenvalue; C – canonicalical correlation; L – Wilks lambda; X2 – Chi – square; DF – D. F.; P – sing. level

In the area of sensomotor reactions of multilateral body parts to light and sound stimulus that form the first pair of canonical variables, it can be noticed that the factor of reactions for multilateral body parts to sound stimulus is dominant, and that it represents the main generator of the joint variance. All variables of that space have significantly high projections, even though a slight curve is noticed towards the upper limbs (table 4).

Table 4. Vectors of transformation into canonical variables (W) and canonical factors (F) isolated in the area of sensomotor reactions of multilateral body parts to light and sound stimulus

VARIJABLE	W1	W2	F1	F2
1. SSNLM	-0.9097	0.1827	0.6670	-1.2731
2. SSRLM	-0.1565	0.0154	1.0787	1.6763
3. SSNDM	1.4198	-0.1040	0.2594	0.1429
4. SSRDM	0.0024	0.9179	-1.5740	-0.5946
1. SZNLM	-1.1546	-0.4905	0.5041	2.1363
2. SZRLM	-0.7563	0.0160	2.0819	0.0049
3. SZNDM	1.9609	0.0202	0.7179	-1.3607
4. SZRDM	0.1930	1.2459	-2.5687	-0.1930

Key (see Table 1); W1 - canonical variables; F1 -canonical factors

However, a group of variables of sensomotor reactions of multilateral body parts to light stimulus has significantly smaller orthogonal projections towards an isolated canonical dimension. Significant projections towards the isolated canonical dimension have reactions of the right hand, left arm and the largest left leg. A certain curve of the area of sensomotor reactions of multilateral body parts towards the upper extremities is significantly discernable.

The sensory impulse leads to a strong excitation of the reticular formation or the bulboreticular facilitating area (mesencephalic and upper pontine regions of the reticular formation). Although this is about different levels of cohesion within these two regions, the main generator of joint variance are probably those regulative mechanisms from which structuring and impulse conveyance through nerve channels is dependent on, when there is a reaction to various external stimuli, simultaneously with all body parts. That means that the organism reacts to the external stimulus as a whole regardless if it is only a reaction of an individual body part or the whole body.

DISCUSSION

Sensomotor reactions incur under the influence of stimulus to sensors in the body, which reach their stimulus threshold and provoke a series of functional processes which give a certain physical answer. The sample subjects for this research list 20 subjects, of male gender, ranging from 20 to 22 years of age, a research of sensomotor reactions of multilateral and unilateral body parts was conducted. The process of collecting data and setting parameters was conducted using an instrument called the KINESIOMETER (M. Dodig, 1987), hooked up to an electronic computer, with an adequate periphery, with application of program support for analogue – digital conversion in the programming language SIMON'S BASIC. In the space of sensomotor reactions of multilateral body parts to light and sound stimulus, it is discerned that the reaction factor of multilateral body parts to sound stimulus is dominant, and that it represents the main generator of the joint variance of the first pair of isolated canonical dimension. All variables of this space have significantly high projections, although a slight curve towards the upper limbs is discerned. The second pair of isolated canonical dimension for the most part belongs to the space of reactions of multilateral body parts to light stimulus. Efficient functioning of the perceptive system towards sound and light stimulus, emission signal speed from the receptor (channel permeability, efficiency of data decoding device and efficiency of data transmission), speed of synaptic signal transmission (number of synaptic connections and flow through synaptic barriers) as well as efficient functioning of commissural connections between hemispheres represents the basic reason for obtained results. The basic reason for variability and covariability within the reaction time to light and sound signal probably incurred as the answer to a joint mechanism for structuring and speed of transmission impulse through afferent and efferent channels. Thus, organism's sensomotor reactions aren't either the simple or elementary characteristic of the organism, regardless of the nature of simplicity. This ability is, firstly, just a special mode of functioning of the entire system of reaction regulation and control.

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