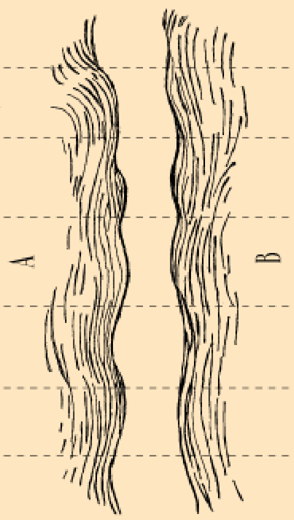
Le Cours de Linguistique Générale 1916-2016

Genève - Paris • 2016 - 2017



TRAVAUX DES COLLOQUES

LE COURS DE LINGUISTIQUE GÉNÉRALE, 1916-2016. L'ÉMERGENCE, LE DEVENIR

Éditeurs scientifiques : Daniele GAMBARARA, Fabienne REBOUL.

Patrizio PAOLETTI, Joseph GLICKSOHN, Federica MAURO, Tania DI GIUSEPPE, Tal DOTAN BEN-SOUSSAN, « Psychological and other aspects of the sign arbitrariness »

Communication donnée dans l'atelier de Jean-Yves Beziau, ***The Arbitrariness of the Sign***, au colloque **Le Cours de Linguistique Générale, 1916-2016. L'émergence**, Genève, 9-13 janvier 2017.

CERCLE FERDINAND DE SAUSSURE

N° D'ISBN : 978-2-8399-2282-1

Pour consulter le programme complet de l'atelier de Jean-Yves Beziau,

The Arbitrariness of the Sign :

https://www.clg2016.org/geneve/programme/ateliers-libres/the-arbitrariness-of-the-sign/

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PHASE: from art to neuroplasticity
The case of embodied symbols

Patrizio Paoletti, Joseph Glicksohn, Federica Mauro, Tania Di Giuseppe, Tal Dotan Ben-Soussan

ABSTRACT. In the current article, we will bring forth the subject of embodied symbols and discuss the possible underlying neuronal mechanisms mediating the comprehension of these symbols, focusing on the motor system. We will focus on three main examples, related to (1) structures (such as the labyrinth), (2) visual stimuli (e.g., sculptures) and (3) embodied symbols utilizing the human body (e.g., symbolic hand gestures). Finally, the implications of embodied symbols will be discussed through the PHASE (Philosophy, Art, Science and Economics) framework. PHASE links philosophical ideas of man's improvement through creative art and its examination through science towards the improved economy of self. Utilizing this perspective, we will discuss scientific experiments related to embodied symbols in art and neuroscience.

In this context, we will focus on the theory of embodied cognition and embodied language, which has claimed that cognitive and linguistic systems re-use the structures and the organization characterizing the motor system. While de Saussure [1983] has argued that the linear-segmented character of spoken language is a property that arises due to the unidimensionality of language, meaning is multidimensional; physical gesture is not restricted to breaking down meaning complexes into segments. As Goldin-Meadow has suggested in her book *Hearing gesture: How our hands help us think*: "Gestures are free to vary on dimensions of space, time, form, trajectory, and so on, and can present meaning complexes without undergoing segmentation or linearization." ([Goldin-Meadow, 2005], pp. 25). Although the current article is not a systematic review, it would like to suggest that objective art may exist, in which specific properties of the stimuli (e.g., form, proportion and frequency) can produce a specific neuronal and behavioral response. In addition, these effects may be mediated, at least in part, by the motor system. Understanding the effects of specific characteristics of the stimuli and the possible underlying mechanism may architects and therapists, as well as parents and teachers to choose the best stimuli in order to voluntarily orient themselves and others towards the inner state which they would like to achieve.

0. Introduction

The study of language is closely linked to the study of the mind. However, long before the creation of languages, visual perception and movement were the only way for mankind to perceive the outer world [Sayin 2014]. An important example is the distinction between *sign* and *symbol*, which has been drawn with the problem of contingency in mind. Ferdinand de Saussure acknowledged this usage in his *Course of General Linguistics*, published in 1916: unlike the concept of sign, the concept of symbol refers to a semiotic unit that, "...is never wholly arbitrary; it is not empty, for there is the rudiment of a natural bond between the signifier and the signified." [de Saussure, translated by Roy Harris. London: Duckworth, 1983].

According to Wittgenstein, the distinction between a sign and a symbol is that the sign is the physical aspect of a symbol, the inscription or mark or sound; it is "what can be perceived of a symbol" ([Wittgenstein, 1929], pp. 3.32). The symbol, on the other hand, is "the sign taken together with its logico-syntactical employment" ([Wittgenstein, 1929], pp. 3.327). Thus, "In order to recognize a symbol by its sign we must observe how it is used with a sense" ([Wittgenstein, 1929], pp. 3.326). The distinction between a sign and a symbol focuses attention on the connection between the sense of a sign and its use: it is in use that the sense of a sign (the essence of a symbol) is revealed or determined.

Arbib [2005] has argued that arbitrary signs first evolved in gesture, which was more amenable to iconic representation, and that this protosign provided the “scaffolding” for vocal-based abstractions. He further suggests that the vocal signs of human language are evolved from the gestural signs of some protolanguage, and this may explain why the production of vocal signs in the human brain is controlled by Broca’s area, the motor area which controls manual actions and speech.

1. From sign to symbol, and the motor system

In *Language within our grasp*, Rizzolatti and Arbib [1998] have stated that the premotor cortex in monkeys contains neurons that are activated both when the monkey grasps or manipulates objects and when it observes the experimenter making similar actions. These neurons, called *mirror neurons*, appear to represent a system that matches observed events to similar, internally generated actions, and in this way forms a link between the observer and the actor. Since then, many experiments have concluded that a mirror system for gesture recognition also exists in humans and includes Broca’s area [Rizzolatti and Arbib, 1998]. Thus, Rizzolatti and Arbib [1998] have proposed that such an observation/execution matching system provides a necessary bridge from ‘doing’ to ‘communicating’, as the link between actor and observer becomes a link between the sender and the receiver of each message.

Mirror neurons may play a role in representing not only signs but also their meaning. Because actions are the only aspect of behavior that are inter-individually accessible, interpreting meanings in terms of actions might explain how meanings can be shared. Behavioral evidence and artificial life simulations suggest that seeing objects or processing words referring to objects automatically activates motor actions. It has further been claimed that the realization that arbitrary labels could be attached to concepts, could have started spoken language with the typical arbitrary relationship between concept and sound pattern [MacNeilage and Davis 2000. Yet, recent studies suggest that sound-symbolic mappings are not arbitrary and language-specific, but rather reflect some more general phenomenon which extends cross-linguistically [for a review see, Perniss, Thompson, and Vigliocco, 2010], leading to the statement that:

> Current views about language are dominated by the idea of arbitrary connections between linguistic form and meaning. However, if we look beyond the more familiar Indo-European languages and also include both spoken and signed language modalities, we find that motivated, iconic form-meaning mappings are, in fact, pervasive in language… we review the different types of iconic mappings that characterize languages in both modalities, including the predominantly visually iconic mappings found in signed languages. Having shown that iconic mapping are present across languages, we then proceed to review evidence showing that language users (signers and speakers) exploit iconicity in language processing and language acquisition. While not discounting the presence and importance of arbitrariness in language, we put forward the idea that iconicity need also be recognized as a general property of language, which may serve the function of reducing the gap between linguistic form and conceptual representation to allow the language system to “hook up” to motor, perceptual, and affective experience. ([Perniss et al. 2010], p. 1)

In addition, languages commonly conceptualize the past as *behind*, the future as *in front of*, and the present as *here* or co-locational with the space around the body. Behavioral data suggest that such conventions in language are not arbitrary [Kranjec and Chatterjee, 2010], that is time appears to be thought about as well as talked about in terms of space. In addition, Lakoff in his neuroscientific theory of form in art suggests that: "form can be at once embodied (in the sensory-motor system), permitting inference and subject to metaphorical interpretation, while being "abstract" …Form has to do with us, in particular with the kinds of embodied structures we impose by virtue of our bodies and brains" ([Lakoff, 2006], p.167).

The path proposed here is based on PHASE [Paoletti, 2011], which may help organizing the data presented in the current chapter, where disciplines interacted with a common focus: the human being and his/her possible development. Art, understood as a discipline which establishes a link between the sign and its representation, guides us through the symbol as a path towards the destination that each human being yearns for: developing his/her own capabilities [Paoletti, 2008b]. The aesthetic experiences provided by architecture, as well as by bodily experience (e.g., training such as Quadrato Motor Training (see section 2.3.) and Aikido, as well as mudras (see section 4.1)) can constitute the signs of the philosophical representation of the human being, which holds the meaning of anticipating the experience by means of the narration of what the stimulus evokes. As such, symbols disclose a precise experience for the participant, the experience of his/her possible evolution [Paoletti, 2015]. Together, these lead us to explore the case of embodied symbols.

2. The case of embodied symbols

> *The history of symbolism shows that everything can assume symbolic significance: natural objects (like stones, plants, animals, men, mountains and valleys, sun and moon, wind, water, and fire), or man-made things (like houses, boats, or cars), or even abstract forms (like numbers, or the triangle, the square, and the circle). In fact, the whole cosmos is a potential symbol.* [Carl Gustav Jung, Man and His Symbols, 1968].

According to Anderson [2010], evolution works in a conservative way, building on previously formed systems. Consequently, the theory of embodied cognition [Wilson, 2003] and especially of embodied language [Gallese and Lakoff, 2005; Glenberg and Gallese, 2012] claims that cognitive and linguistic systems re-use the structures and the organization characterizing the motor system. From this perspective, language comprehension is rooted in action, as it recruits the same neural areas that are active while performing movements. Much evidence for embodied language comes from psychophysiological and neuroimaging studies documenting an activation of the motor system during the comprehension of nouns referring to manipulable objects (i.e., tools), which parallels the activation of the same system while both actively manipulating and passively viewing these objects [Martin, 2007].

The motor system not only allows planning actions to be executed, but also to represent them as well. Thus, if the same mechanism that drives to action execution is virtually activated, we can represent it and represent objects that correspond to it. The motor system is automatically activated when participants (a) observe manipulable objects; (b) process some linguistic stimuli (e.g., action verbs), the meanings of which imply bodily action; and (c) observe the actions of another individual [Mahon and Caramazza, 2008]. Though the motor system may not be the sole participant, it has been consistenly suggested that the mechanisms that give rise to consciousness may have evolved in the service of action [Prinz, 2009].

In the current article, we set out to examine three interrelated embodied types of symbols, including: (1) structures, (2) visual stimuli and (3) bodily postures (e.g., the labyrinth, visual forms and symbolic hand gestures, respectively). We start from PHASE (Philosophy, Art, Science and Economics) philosophical vision of man and what he can become [Paoletti, 2008b, 2011], through which we will discuss some scientific experiments related to embodied symbols in art and neuroscience. This is also aimed at suggesting some of the underlying features of specifically structured stimuli, which can, if practically utilized consciously, help in the path towards neuroplasticity and self-improvement.

2.1. Structures

We chose to start with physical structures and the example of the labyrinth, as it has long been used as a metaphor to symbolize the mind. After the labyrinth, we will give two other examples, related to specifically-structured rooms and temples.

2.2. The Labyrinth

Charles Peirce [Peirce, 1905] interpreted language visually. This led him to the idea of the diagrammatisation of logic and to the theory of existential graphs as “moving pictures of thought”. This idea goes back to European literature describing the mind as a labyrinth. The labyrinth is an ancient tool that has been in existence for thousands of years, and its form is found in almost every religion. The classical is a seven-circuit labyrinth originally found on the Isle of Crete (See Figure 1 A), home to the mythical Minotaur [West, 2000]. The earliest labyrinths were drawn on walls or other surfaces. Gambitus, an anthropologist, reported that she discovered some of the earliest evidence of labyrinth-like images on a figure in the Ukraine dated 15,000 to 18,000 BCE [Schaper and Camp, 2000]. Different cultures have used the labyrinth for various purposes ranging from religious ritual to personal symbol.

Full-sized walking labyrinths were developed approximately 1,500 years ago. One labyrinth was discovered among the Nayca people who used the labyrinth for a ritual procession to honor the spirits they represented in ritual ceremonies [Westbury, 2001]. The Chinese used labyrinths as a way to keep time in ceremonial rituals. In Sweden, Finland, and Estonia, labyrinths were used as symbols of protection by fisherman to insure a good catch [Westbury, 2001]. An 11-circuit labyrinth pattern was placed on the floor of Chartres Cathedral in France during the twelfth century (See Figure 1 B). It has been speculated that the purpose of the labyrinth was to allow pilgrims to use it as a substitute for a pilgrimage to the Holy Land [Artress, 1995; Wallace-Murphy and Hopkins, 2009].

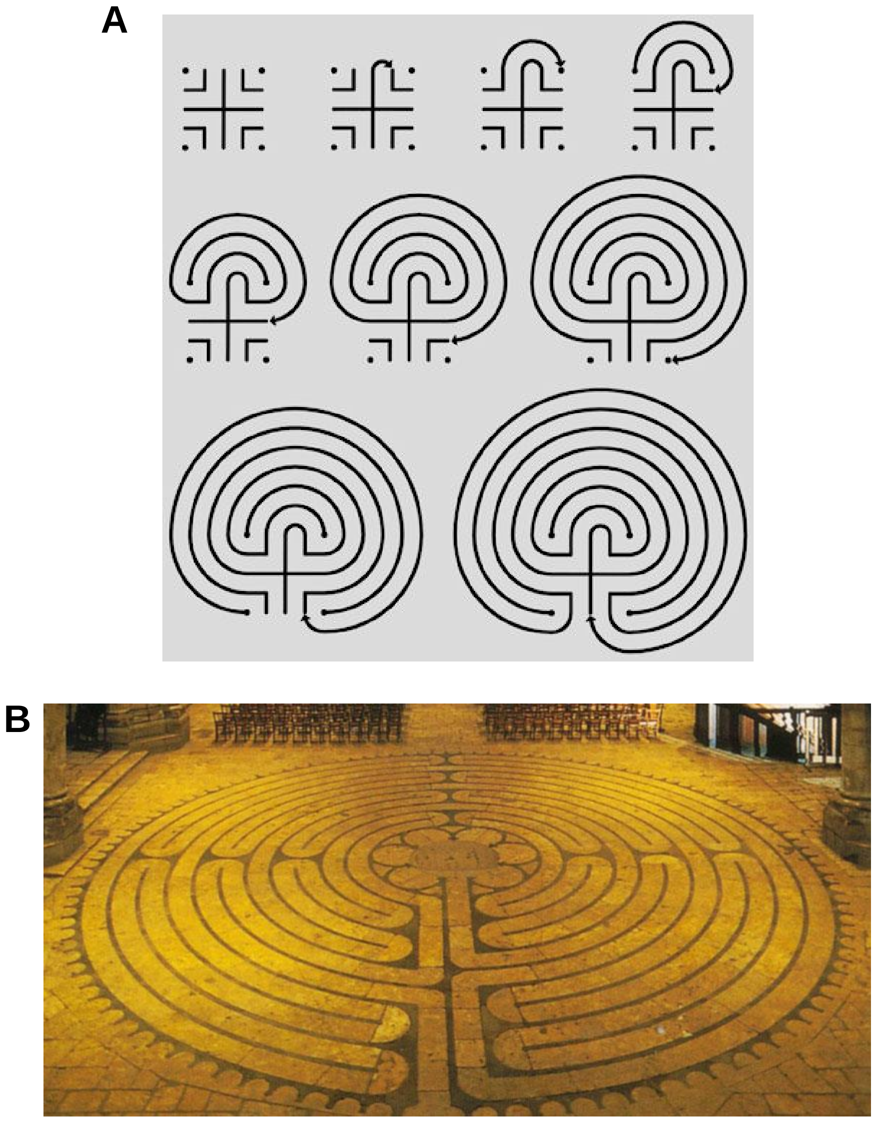


Figure 1. A. Classical Seven-Circuits Crete Labyrinth.
B. The 11 Circuits Labyrinth represented on the floor of Chartres Cathedral in France.

Today, labyrinths are being built in a variety of settings, which include churches, retreat centers, hospitals, university campuses, public parks, and street spaces as well as private spaces. The first modern labyrinth was built in 1997 at California Pacific Medical Center in San Francisco as part of an integrative medicine clinic [Scherwitz et al., 2003].

The contemporary use of the labyrinth has been primarily focused on meditation and psychotherapy [Artress, 1995; Johnson, 2001]. According to West [2000], the labyrinth is one of the oldest contemplative tools known to humankind. In addition, its specifically-structured qualities can be transferred to individuals through a process called isomorphism which refers to the correspondence between an external state and its internal manifestation [Hinz, 2009]. Such statements associate labyrinths with embodied movement and the movement of the psyche, making the labyrinth a meaningful symbol for the processes involved in a therapeutic situation [Hanson, 2015].

Part of the labyrinth's allure is that it is an archetype with which we can have direct physical experience. Archetypes are defined as universal forms or figures that exist independently of the human psyche in the collective unconscious and are thought to bring meaning to life experiences. Cultures throughout time have depicted sacred circles, or mandalas, as a representation of the cosmos and psyche. The labyrinth is an archetypal symbol of wholeness that includes an unobstructed path from the entrance to the center [Bord, 1976; Jung, 1968]. Two other symbols related to wholeness are the *Egg* and the *Square*.

2.3. The Egg and the Square

While architecture and the arts have acknowledged the importance of symbols for millennia, current studies in neuroscience have only recently started to examine the objective effects of esthetics and art on psychological and neural states. Whether different symbols have shared psychological and neural effects remains an open question. Two of the most ancient symbols are the *Square* and the *Egg*.

For the embodied square, consider *Quadrato Motor Training (QMT)*. QMT is a sensorimotor movement meditation, which is conducted on a 50 x 50 cm Square in which the participant moves according to specific oral instructions (see Figure 2A). QMT aims to promote a state of enhanced attention and mindfulness, in which the participant is required to divide attention between the currently executed motor response and online cognitive processing concerned with producing the next movement [Ben-Soussan et al., 2013, 2015]. QMT was found to improve cognitive functioning, including enhancing creativity, reflectivity, and information processing [Ben-Soussan et al., 2013, 2015a]. In terms of neural functioning, QMT was found to enhance EEG alpha (8-12 Hz) activity both within the frontal and parietal areas [Ben-Soussan et al., 2013, 2015a;], as well as in the cerebellum [Ben-Soussan et al., 2015b]. In turn, QMT-induced changes in gray matter volume and fractional anisotropy changes in the cerebellum were positively correlated with increased creativity [Ben-Soussan et al.,2015a]. In addition, QMT was found to enhance functional connectivity [Ben-Soussan et al., 2013; Lasaponara, Mauro, Carducci, Paoletti, Tombini, Quattrocchi, Mallio, Errante, Scarciolla and Ben-Soussan, 2017]. Phenomenologically, QMT was found to enhance attention and concentration, as well as the experience of altered states of consciousness (ASCs), including spontaneous visualization, intuition, and sense of wonder [Ben-Soussan et al.,under review].

What could be the implications of adopting a meditative mode of experience while situated within a space that is either square-shaped, or egg-shaped? In other words, what would happen if we embody the Square and the Egg and apply them in specifically-structured training? As Nalimov has insightfully written, “Any attempt to penetrate into the depth of a symbol can only be based on meditation” [Nalimov, 1982], p. 165). In a recent study, QMT as a form of walking meditation in a squared space was compared to meditation when the body is seated still in a spherical space [Ben-Soussan et al.,under review]. For the embodied Egg, a whole-body perceptual deprivation (WBPD) OVO chamber (Figure 2B), which is a specifically structured room in the form of an egg ('Uovo' in Italian), was utilized.

For the comparison of the embodied Square and Egg, practitioners of breathing meditation novice to these paradigms performed a session of either OVO or QMT, followed by a semi-structured interview. The reported experiences were classified into three content units, related to alterations in the perception of: (1) Time, (2) Space and (3) Bodily sensation. Preliminary analysis of first-person reports collected during a meditation session inside the OVO uncovered subjective alterations in the perception of time and space, emotion and cognition [Ben-Soussan et al., under review]. More specifically, significantly more reports related to alteration of Time were reported in the OVO group compared to the QMT group, while the reverse was found for Body sensations. When examining the effect of the OVO on a task of time production (TP), we found that for those participants reporting a marked change in time experience, such as “the sensation of time disappeared”, their TP data could not be linearized using a log-log plot, suggesting that for these individuals there might be a ‘break’ in the psychophysical function [Glicksohn, Berkovich-Ohana, Mauro and Ben-Soussan, 2017].

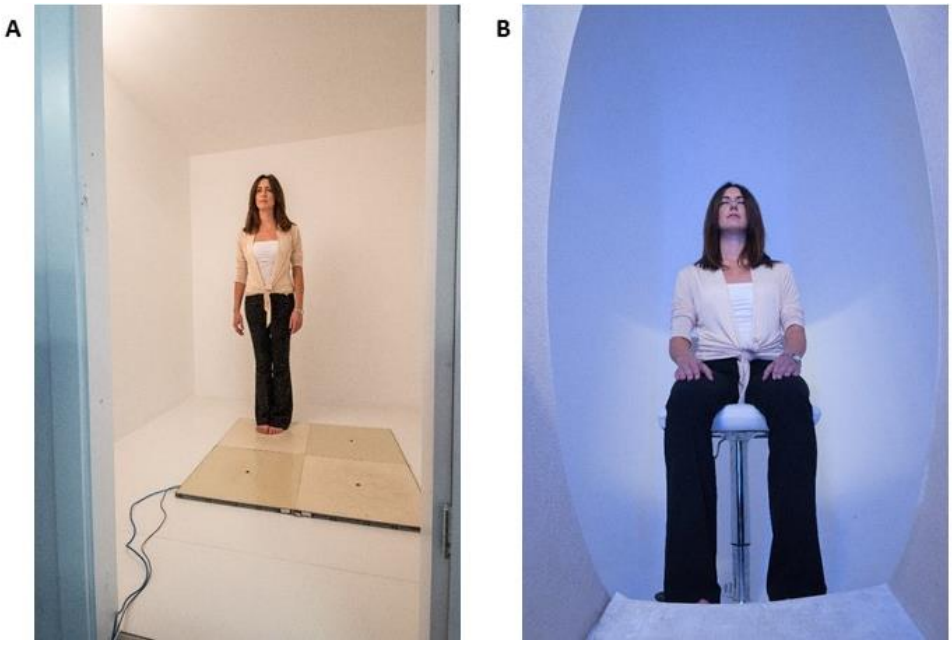


Figure 2. A. A participant during QMT inside the square-shaped space while waiting for the next command. **B.** A participant sitting still inside the OVO Whole Body Perceptual Deprivation (WBPD) chamber.

Interestingly, the Square and the Egg are not only symbols, they are also spaces, or portals [Hume, 2007] that afford altered states of consciousness (ASCs). Of course, the induction of an ASC is a function of the personality of the individual interacting with such an environment [Glicksohn, 1987, 1991]. As Baron and Boudreau insightfully write,

> From an affordance perspective, personality and the environment are related in complementary fashion, similar to the relationship between keys and locks. Personality, in this metaphor, is a key in the search of the "right" lock, whereas the environment … is the lock waiting to be opened so that its affordances can be realized. ([Baron and Boudreau, 1987], pp. 1227).

The Egg and the Square, in interaction with the actions of the individual, afford ASCs that differ in their experiential content [Ben-Soussan et al.,under review], as noted above. When one considers the cognitive set with which the individual enters these spaces—especially a cognitive set encouraging metaphoric-symbolic cognition [Glicksohn and Avnon, 1997-98]—then the symbolic nature of these spaces will readily enable the individual to experience an ASC. In fact, the Egg, which could be regarded as a whole-body *Ganzfeld*, enables both colour and sound to be experienced "… *as bodily and vital sensations*" ([Werner, 1978], pp. 163). These are "… essentially felt in the body and on the body, they represent general states of the body, psychic and physical at the same time…." ([Werner, 1978], pp. 162-163). Exposure to such a whole-body, immersive *Ganzfeld* can induce a drastic change in time perception, as one individual was startled to discover [Gadassik, 2016], and this is a familiar hallmark of the induction of an ASC [Glicksohn, 2001].

2.4. Temples

The egg and the square, as ancient symbols, are also manifested in architecture. For example, in Hindu Temple architecture, the cosmos is represented by the circle, and the process of making an architectural model of the cosmos involves the representation of a circle in a square grid in two-dimensional construction and of an ellipsoid (the cosmic egg) in a cubical grid in three-dimensional construction [Trivedi, 1989, Dutta and Adane, 2014]. The basic plan of many temples is built upon the Vastu Purush Mandala, which is a square, representing the earth [Michell, 1977]. In the foundation of many Hindu temples, the cosmos is embodied by laying down the diagram of Vastu Purush Mandala on a selected ground. This diagram reflects the image of cosmos through its fractal qualities. The Mandala can be considered an ideogram, while the temple is the material manifestation of the concepts it embodies [Trivedi, 1989].

The square is considered to symbolize order and unequivocal form, while the circle represents movement, and therefore time. The square, with its potential to include competing elements, when enclosing a circle represents the dimensions of both space and time. Importantly, two ancient texts coming from two of the Chinese and Jewish traditions, namely, the Canon of Changes (Yi Jing) and the Book of Creation (Sepher Yetzirah) describe and relate them to the magic square [Petrella, 2011]. From whole-body structures we now move to visual stimuli.

3. Visual stimuli

Objective art has been found to be related to the subconscious, to ASCs and to collective memory. Painted hallucinatory images have been found in prehistoric caves [Clottes and Lewis-Williams, 1998], and scratched on petroglyphs [Patterson, 1992]. Interestingly, hallucinatory images are seen both when falling asleep and while waking up [Mavromatis, 1987], as well as following sensory deprivation [Zubek, 1969], the use of anesthetics and in “near-death” experiences [Blackmore, 1983], when seeing bright flickering light [Purkinje, 1819; Smythies, 1960], or when applying deep binocular pressure on the eyeballs [Tyler, 1978].

3.1. Forms

In this context, *form constants*, namely typical geometric patterns, can spontaneously be produced by the brain under the influence of drugs [Klüver, 1966], flickering lights [Purkinje, 1819; Young, Cole, Gamble and Rayner, 1975; Becker and Elliott, 2006; Allefeld, Pütz, Kastner and Wackermann, 2011; Billock and Tsou, 2007, 2012], or clinical disorders [Billock and Tsou, 2012]. These forms (e.g. tunnels and funnels, spirals, lattices, including honeycombs and triangles, and cobweb) are often accompanied by a modulation of brain rhythmic activity [for review see Mauro, Raffone and VanRullen, 2015]. It is interesting to note that during full-field flickering light, the exact class of geometric pattern experienced—radial, spiral, grid, etc.—depends on the precise flicker rate [Becker and Elliott, 2006; Allefeld et al., 2011; Elliott, Twomey and Glennon, 2012], and thus on the frequency of rhythmic brain activity [Allefeld, Pütz, Kastner and Wackermann, 2011].

Both theoretical work [Bressloff, Cowan, Golubitsky, Thomas and Wiener, 2001] and physiological studies have examined and verified the direct correspondence between the geometrical structure of visual hallucinations and the spatial organization of visual cortex (retinotopy and cortical magnification), and the mathematical foundation for this correspondence [Hammer, 2016]. While the contribution of brain oscillations is recognized, it is not fully understood [Shevelev et al., 2000; Rule, Stoffregen and Ermentrout, 2011; Billock and Tsou, 2007, 2012; Muthukumaraswamy et al., 2013]. In most cases, the images are seen in both eyes and move with them, but also in closed eyes and dark spaces. Similarly to Plato’s (427-347 BC) cave metaphor, this can be interpreted as the fact that they are generated in the brain - in the visual cortex [Bressloff et al., 2001].

The appearance of these “form constants” in the everyday experience of entoptic phenomena [Glicksohn, Friedland and Salach-Nachum, 1990-91], but especially in dreams [Shepard, 1983], might be viewed as an “archaic form of symbolic language” ([Sayin, 2014], pp. 429), or as a basis for symbolic imagery [Hunt, 1989]. Photic stimulation at certain critical frequencies (especially within the alpha band) will induce in certain individuals both an ASC and such imagery [Geiger, 2003;

Glicksohn, 1986-87; Salansky, Fedotchev and Bondar, 1998]. As Smythies indicated regarding such imagery, his participants "… in general found them very interesting, even fascinating, and one even expressed the conviction that they possessed a power of addiction over the subject as one developed an active desire to go on looking at them…." ([Smythies, 1959], pp. 111).

These "form constants" which appear and develop into three-dimensional moving forms are another familiar hallmark of the experience of an ASC [Oster, 1970; Siegel and Jarvik, 1975]. Shanon describes the imagery that appears during the ASC:

> The geometric patterns may be two- or three-dimensional. In the former case they are like arabesques; these compose tapestries that entirely cover the inner visual field. Unlike the two-dimensional geometric patterns, the three-dimensional ones usually define structures positioned in space; hence, they need not be fully coextensive with the inner visual field. Often the patterns are like multicellular honeycombs whose cells are usually pentagonal or hexagonal. The total construction may be linear-polyhedral or oval-circular; it may be static, or it may be pulsating or vibrating. At times, the geometric patterns may seem to defy ordinary real-world Euclidean geometry; some persons that I interviewed made reference to higher orders of spatial dimensionality. ([Shanon, 2002], pp. 88).

This imagery, coupled with the experience of an ASC, interpreted to be the symbolic imagery experienced by a shaman in a cave, is purported to be the source (and inspiration) for rock art, as noted above —an argument promoted in a series of important publications by Lewis-Williams and his associates [Lewis-Williams, 1986, 1991, 2004; Lewis-Williams and Dowson, 1988, 1993; Lewis-Williams and Loubser, 1986].

3.2. Frequencies

Computational models have revealed that the geometry of hallucinations can be related to functional neuro-anatomy. While experimental evidence links both visual flicker and hallucinogenic drugs to upward and downward modulations of brain oscillatory activity, the exact relation between brain oscillations and geometric hallucinations remains a mystery. To shed light on this issue, namely, the bidirectional link between geometry form and brain frequency manifested in the brain, Mauro et al. [2015] have demonstrated that in human observers, this link is bidirectional. The same flicker frequencies that preferentially induced radial (10 Hz) or spiral (10 –20 Hz) hallucinations in a behavioral experiment involving full-field uniform flicker without any actual shape displayed, also showed selective oscillatory EEG enhancement when observers viewed a genuine static image of a radial or spiral pattern without any flicker (See Figure 3). This bidirectional property constrains the possible neuronal events at the origin of visual hallucinations, and further suggests that brain oscillations, which are strictly temporal in nature, could nonetheless act as preferential channels for spatial information.

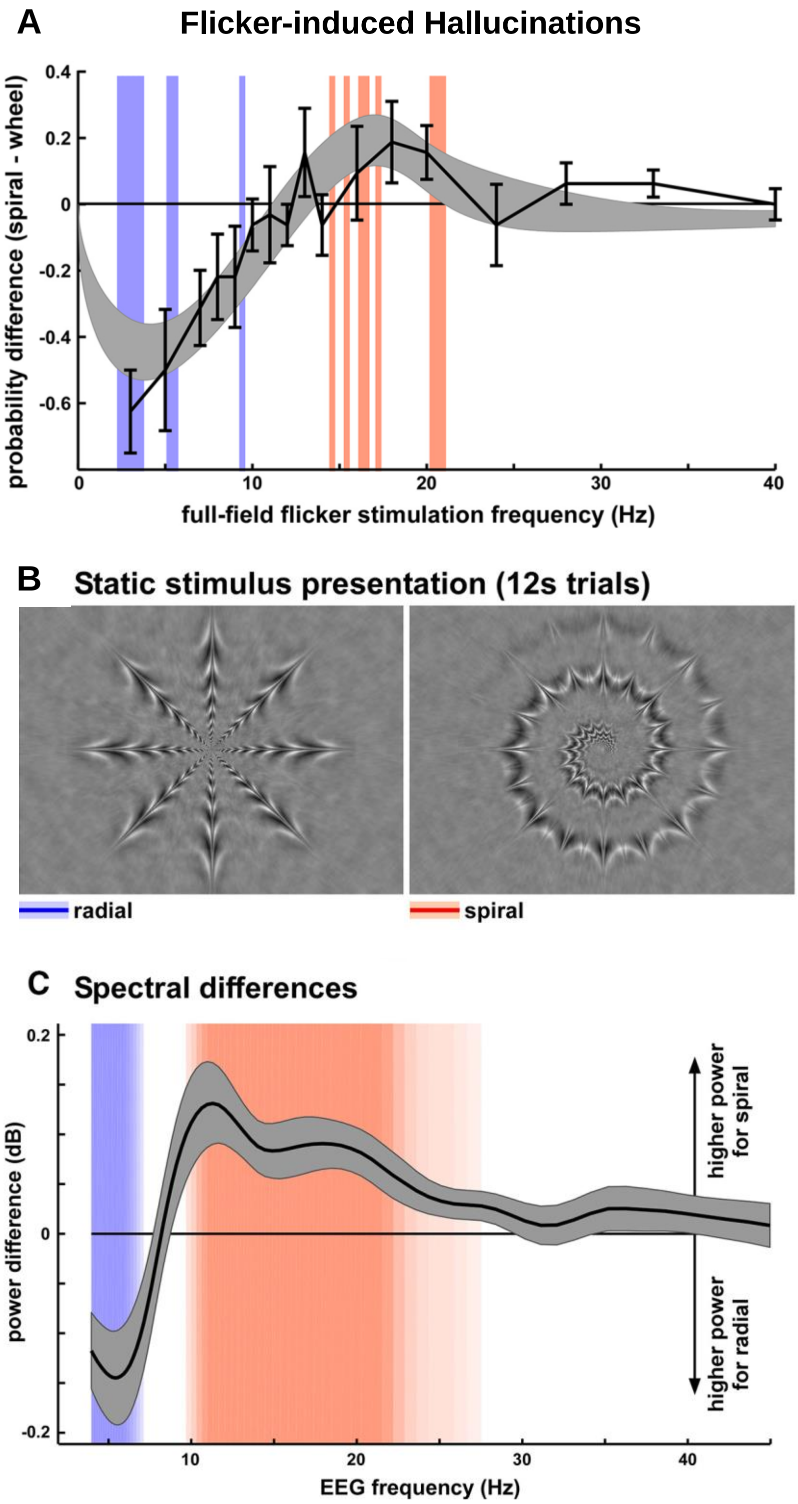


Figure 3. *Bidirectional link between Brain Oscillations and Geometric Patterns.* Figure adapted from [Mauro et al., 2015]. **A.** Difference between report probabilities of the two shapes (black line; error bars represent SEM across observers). The shaded gray area indicates the mean difference (SEM across observers) between Weibull-function fits of individual subjects. The minimum and maximum frequencies for this difference are 4 and 17 Hz, respectively. Each colored vertical line in the background denotes the minimum (blue line) and maximum (red line) frequencies of an individual subject (line thickness indicates the number of subjects with the same frequency); **B.** Facsimile versions of the radial and spiral hallucinatory patterns. **C.** Spectral power differences between EEG

signals recorded during static viewing of radial versus spiral images, with blue denoting frequencies of higher power for radial images and red higher power for spiral images.The relationship between flicker frequency and class of geometric pattern experienced seems to follow a basic rule: Patterns observed as higher frequencies "were more finely detailed and composed of smaller elements than those of the coarser images induced at lower frequencies…." ([Stwertka, 1993], p. 71). More specifically, as Sayin concludes, "Flicker phosphenes created by stroboscopic lights or mind-machines tend to be more amorphous at low frequencies (1-4 Hz), tend to fall into web, spiral, or cloverleaf patterns at medium frequencies (4-9 Hz), and tend to lock into grid, honeycomb, or checkerboard patterns at higher frequencies (9-16 Hz). Flicker phosphenes will have slow lateral drift at lower frequencies; a rotational drift at medium frequencies; and will maintain stability or produce fast lateral drift at higher frequencies" ([Sayin, 2014], pp. 431]).

3.3. Sculptures and ratios

If specific geometric patterns can produce specific brain frequencies, may this also be manifested in other aspect of brain function? The main question Di Dio and colleagues [2007] addressed was whether there is objective beauty, i.e., if objective parameters intrinsic to works of art are able to elicit a specific neural pattern underlying the sense of beauty in the observer (for example see Figure 4), and may these patterns be measured using magnetic resonance imaging (MRI). Their results indicated a positive answer to these two questions.

More specifically, in addition to general activation resulting from observing the sculptures, especially in the premotor cortex (which is known to become active during the observation of actions done by others), the presence of the golden ratio in the stimuli presented determined brain activations different to those where this parameter was violated. The feature that changed the perception of a sculpture from "ugly" to beautiful appears to be the joint activation of specific populations of cortical neurons responding to the physical properties of the stimuli and of neurons located in the anterior insula, known to mediate emotions [Damasio, 1999, Damasio et al., 2000, Critchley et al., 2005]. As can be seen in Figure 5, the act of observing canonical sculptures, relative to sculptures whose proportions had been modified, produced the activation of the precuneus, prefrontal areas, and right anterior insula.

In addition, when examining subjective beauty, Di Dio et al., [2007] also found that in the condition in which the viewers were asked to indicate explicitly which sculptures they liked, there was a strong increase in the activity of the amygdala, a structure that responds to incoming information laden with emotional value [Paoletti, Glicksohn, & Ben-Soussan, 2017].

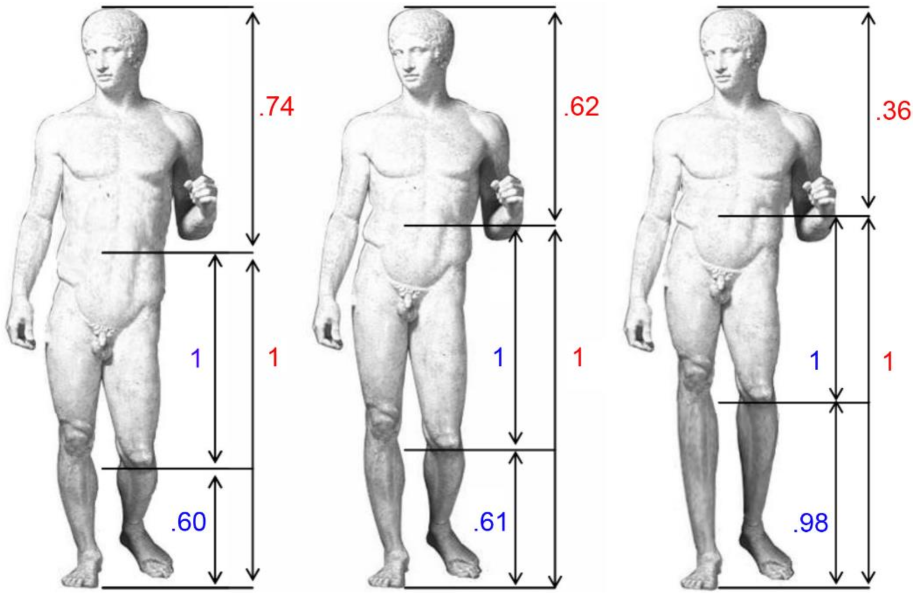


Figure 4. Example of canonical and modified stimuli. The original image (Doryphoros by Polykleitos) is shown at the center of the figure. This sculpture obeys canonical proportion (golden ratio=1:1.618). The golden beauty: brain response to classical and renaissance sculptures. PLoS ONE 11, e1201. The central image (judged-as-beautiful on 100%) and left one (judged-as-ugly on 64%) were used in the fMRI evaluation. Figure from Di Dio, C., Macaluso, E., and Rizzolatti, G. [2007].

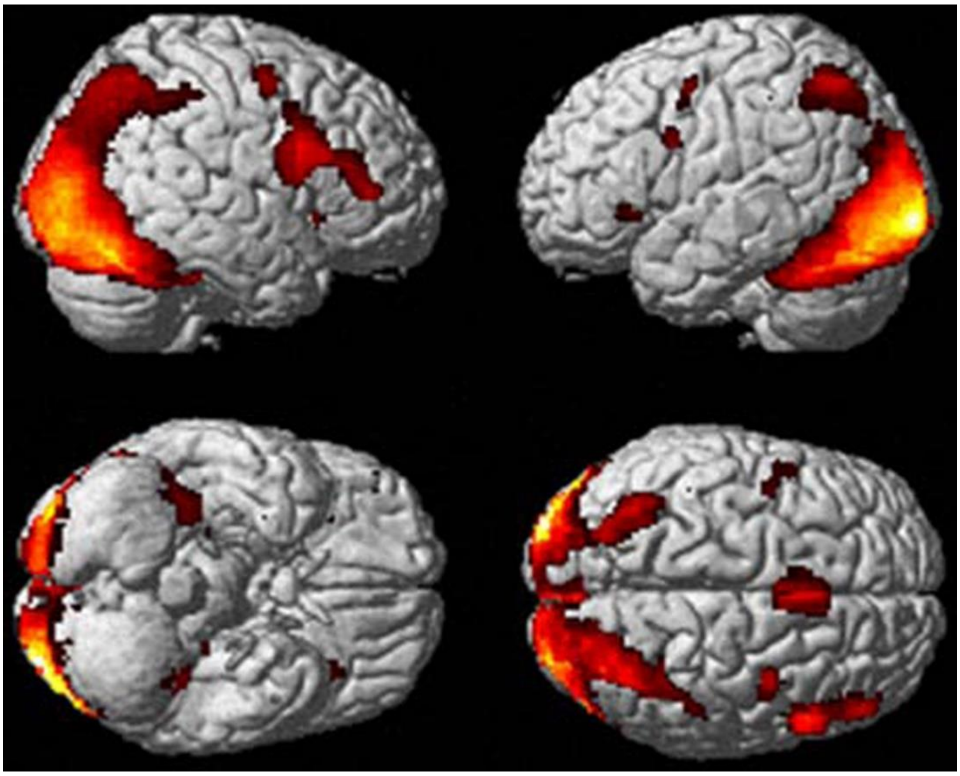


Figure 5. Brain activation of canonical and modified sculptures *vs*. rest. Figure from [Di Dio, Macaluso and Rizzolatti, 2007]. The golden beauty: brain response to classical and renaissance sculptures. PLoS ONE, 2(11), e1201.

Another example is *mudras*, namely, specifically structured hand gestures. An analysis of iconographic elements of mudras can help elucidate the syntax rules within a complex iconographic system. In a rare study examining 11th-century clay sculptures at the Tibetan Buddhist monastery of Tapho in Himachal Pradesh, India, mudras were found to have significant associations with other iconographic elements—in particular, deity type. They could have been used to communicate a semantic unit using hand gesture plus arm position [Reedy and Reedy, 1987]. What would happen if we would embody these symbols utilizing the human body?

4. Embodied - in the body

4.1 Mudras, symbolic hand gestures

Similar to the study of other types of movement and posture [Dael, Mortillaro and Scherer, 2012], the examination of mudras can magnify the role that hands play in life. Studies have consistently shown that when people make gestures with their hands and arms, it helps the thinking process [Goldin-Meadow, 2005; Skipper, Goldin-Meadow, Nusbaum and Small, 2007]. Interestingly, it has even been argued that in some semitic alphabets, such as the Hebrew one, as well as in Greek and other ancient languages, each letter may represent also a hand gesture, and it is at this level that it can form a natural universal language [Tenen, 2013]. Different spiritual religious and philosophical groups around the world have practiced hand gestures [Patra, 2004]. Mudras are an important part in the religious practices of Buddhist and Hindu rituals. The hand has been a symbol for prayer and for the Higher Power [Patra, 2004]. Around 1500 B.C. the Egyptian deity Ra was shown as a sun burst with each ray terminated in an open hand. Each finger has a specific meaning [Patra, 2004]. The type of mudra is determined by various aspects, such as where the fingers are touching. The Prayer Mudra, with hands together at the heart, symbolizes prayer and worship.

In a recent study, Kozhevnikov, Elliott, Shephard and Gramann [2013] examined the effects of hand mudras in peripheral temperature (see Figure 6 for an example). They found that peaks of the peripheral temperature increases were associated with changes in hand mudra positions (as symbolic gestures used in meditation), namely, tensing the hand muscles as well as pressing the fists against the inguinal crease (on the femoral artery) during particular meditative periods.

Figure 6. Hand position during g-tummo meditation. Figure from [Kozhevnikov, Elliott, Shephard and Gramann, 2013]. http://dx.doi.org/10.1371/journal.pone.0058244.g002

4.2. Body Postures

Body movement and gestures can further influence creativity and emotions [Hao, Xue, Yuan, Wang and Runco, 2017, Prinz, 2003]. For example, a recent study has demonstrated that the effects of arm postures on creativity were influenced by body positions (i.e., being seated or horizontal). More specifically, arm flexion and extension in the lying body position exerted effects on solving Alternate Uses problems in a converse pattern compared to that in the seated body position [Hao et al., 2017]. Related to this, another study reported that participants in the open body posture felt more confident, and performed better on cognitive tasks; whereas they felt lack of confidence and performed worse in the closed body posture [Briñol and Petty, 2009]. Given that the open body posture led individuals to feel more confident and dominant, individuals' emotions were affected by social exclusion only when they adopted an open posture rather than a closed posture [Welker, Oberleitner, Cain and Carré, 2013].

A recent study demonstrated that in a relatively long period (90 min), participants in the open posture reported more positive emotions, while those in the closed posture reported more negative emotions [Zabetipour, Pishghadam and Ghonsooly, 2015]. This suggests that open or closed body posture could serve as pleasant or unpleasant cues, eliciting implicit positive or negative emotions, which might reflect on changes in testosterone, feeling of power and tolerance of risk [Carney, Cuddy and Yap, 2010].

These results further confirmed that posing in high-power nonverbal displays (as opposed to low-power nonverbal displays) causes neuroendocrine and behavioral changes. High-power posers experienced elevations in testosterone, decreases in cortisol, and increased feelings of power and tolerance for risk; while low-power posers exhibited the opposite pattern. In short, the authors have concluded that posing in displays of power can lead to advantaged and adaptive psychological, physiological, and behavioral changes, suggesting that embodiment extends beyond mere thinking and feeling, to physiology and subsequent behavioral choices and “that a person can, by assuming two simple 1-min poses, embody power and instantly become more powerful has real-world, actionable implications” [Carney et al., 2010], p.1363).

A more radical claim is that body posture—or, rather, *ritual* body posture—can induce an ASC in certain individuals [Goodman, 1986, 1999]. Ritual body posture is yet another path to ASC induction. We would argue, however, that ritual body posture should be contextualized. If one adopts a ritual body posture within a symbolic space, and given the appropriate cognitive set (and personality), then an ASC may well be induced. Adopting a ritual posture in a group setting in an auditorium [Woodside, Kumar and Pekala, 1997] does not seem to be an optimal test of this hypothesis. That different ritual postures do not necessarily lead to different subjective experiences [Hunger and Rittner, 2015] is not necessarily detrimental to the basic claim advanced by Goodman [1986, 1999]. It might well be that, as with other methods of ASC induction, the paths might be different, but the induced ASC might be the same [Glicksohn, 1993]. Again, in terms of symbols, spaces and embodiment, there is an interaction of the individual’s personality with the (symbolic) environment, and with the way that this environment is embodied, that leads to the variety of subjective experiences that might be realized.

4.2 Sports, QMT, Aikido and Motor primitives

As mentioned above in section 2.3, QMT was found to induce different neuro-cognitive effects, including increased creativity and reflectivity [Ben-Soussan et al., 2013; 2014], as well as electrophysiological, structural and molecular changes [for review see Ben-Soussan et al., 2015b). The results from recent studies demonstrate that QMT can enhance functional connectivity (FC), and increase creativity. In line with previous results, change in frontal FC was significantly correlated with change in creativity [Ben-Soussan et al., 2015a].

These effects can be well explained by the embodied cognition hypothesis, which suggests that neural networks involved in cognition, especially concerning conceptual thought and creative thinking, are related to perception and action. The activation of the sensory-motor system leads to concepts, which are the building blocks of abstract and creative thought [for reviews see Lungarella and Sporns, 2006; Conne et al., 2012]. QMT-induced creativity [Ben-Soussan et al., 2013, Venditti et al., 2015] has been related to the complexity of the movement, and thus to the recruitment load of the motor units required, as well as to the cognitive functions required.

The matter of how motor units are created, organized and used is further addressed in the context of *Schema Theory* [Arbib, 1981], where schemas were defined as the fundamental units for the analysis of behavior, having two variants: perceptual schemas serving for perceptual encoding, and motor schemas serving as control units for movement. Such schemas can be combined leading to coordinated control programs. In this sense, the notion of schema is recursive: the level of activity of a perceptual schema represents a ‘confidence interval’ that the object represented by the schema is indeed present; while that of a motor schema might signal ‘its degree of readiness’ to control a part of an action. Mutually consistent schemas are strengthened, and reach high activity levels to constitute the overall solution of a problem, whereas instances that do not reach the evolving consensus lose activity and thus are not part of this solution. Moreover, from a neuropsychological point of view, a given schema, defined functionally, might be distributed across more than one brain region; conversely a given brain region might be involved in many schemas [Arbib, 1981].

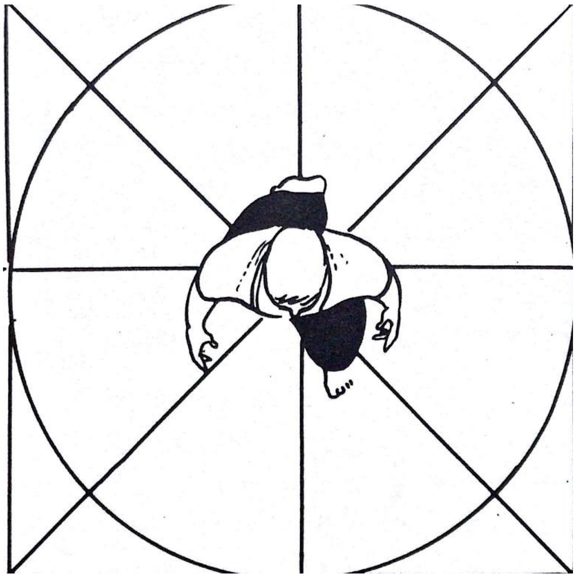
As a matter of fact, specific brain areas, such as the F5 area for grasping movements, seem to contain a “schema vocabulary” that allows to reduce the higher number of degrees of freedom of the actual movement [Gallese et al., 1992; Rizzollatti and Gebtilucci, 1988]. This vocabulary also facilitates the process of learning associations. Interestingly, both behavioral and functional brain imaging data showed that practice resulted in a specific representation of the training sequence rather than changes pertaining to the performance or cortical representation of the component movements *per se*, also suggesting that different levels of performance may be associated with different internal representations of the task [Sosnik et al., 2004] Thanks to the accumulation of experience through practice, a profound hierarchical change takes place in motor planning, shifting from the generation of the sequence of individually planned movement components (i.e., a syntax-dependent performance), to the generation of global modular planned movement, providing more effective solution to the external or internal requests.

The characteristics of the newly acquired co-articulated movements seem to be fundamentally related to the geometrical spatial configuration required for the task, and they could be very different from the initial sum of elements that originally constituted the sequence. This sequence is the product of a series of distinct and successive shifts in the internal representation of the sequence, itself changing as experience accumulates, while not abolishing the previously available schemas, but constituting an additional module especially suited for the task and its context. Thus, the evolution of these motor primitives, with the perfection of performance with practice, may compound the final product of a multi-stage process associated with qualitative changes in the internal representation of the task, and, consequently, an important substrate of motor memory for the skilled performance of the motor sequences [Sosnik et al., 2004].

The attributes of the newly acquired schemas are dictated by the geometrical form of the path. Thus, the geometrical arrangement of the trajectories seems to be an important factor determining the motor learning process. The intrinsic geometrical nature of the movements required by QMT thus seems to represent the key element of a simple and versatile motor training program, leading to a unique blend between cognitive and physical components in an effective formula. As the movements required by motor training get more complex, the geometrical organization of movement schemas appears to be much more articulated. This is particularly true in the case of sports, as well as in the case of dance, where a great degree of coordination is required between body parts, between individuals, between perception and action and between time and space. Dancers can rapidly transform scant visual or verbal information into highly sophisticated movements, also characterized by aesthetic value. Interestingly, such a statement can also be viewed in terms of Aikido, a form of Japanese martial art developed by Morihei Ueshiba, with the aim to redirect the momentum of an opponent's attack, using a series of techniques that tend to unify body and mind, through visualization, breathing and bodily exercises.

It is possible to consider the similarity between the basic geometrical arrangement of movements proposed by QMT and those constituting the substructure of Aikido motor training. In the latter case, the same basic movements acquire more complexity thanks to their projection onto a sphere space, following the "principle of sphericity", which is essential in Aikido's movement syntax, and which is rooted in the '*taiyoku*' symbol from Chinese Taoism, representing the balance of the fundamental elements that compose the origin of the phenomenal world. Each complex Aikido techniqueis based on a fluid and powerful movement, which has three primary types: straight, internal and linear, circular and external, and a combination of the previous two. The linear movement (shintai) has 8 directions on a square (see Figure 7A), while the circular movement (Tai sabaki; see Figure 7B) is developed from arched directions from open and closes circles. When all possible directions are unified along the space of the actor/practitioner, the image of a Dynamic Sphere can be drawn (see Figure 7C) and it is possible to reformulate the movements proposed by the Aikido tradition within the principle of the circularity of action, following the original aim of harmonizing humans to the movement of the universe. Each movement from the tradition is practiced individually in order to understand the specific mechanism, allowing the body to learn how to execute them fluently and rapidly, and subsequently combining them together.

A



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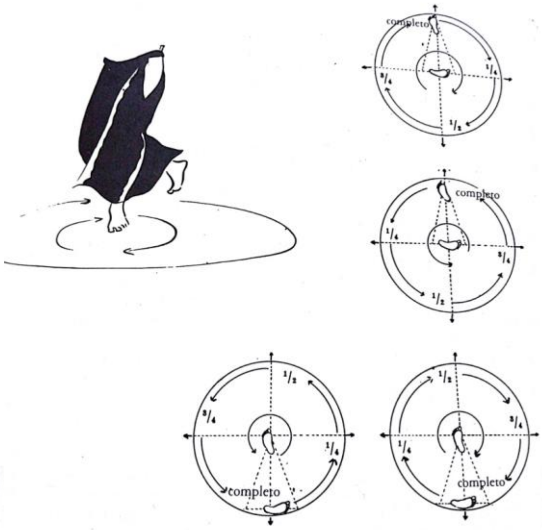
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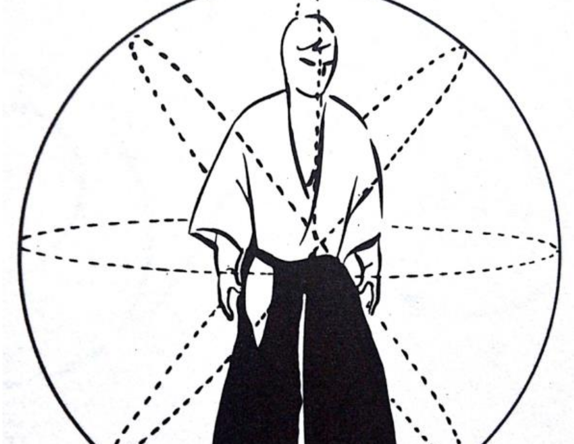

Figure 7. The Aikido fundamental geometry of movement (adapted from [Ratti and Westbrook, 2012]). **A.** Happo undo – The 8 directions exercise. A fundamental exercise consisting of linear movements (Shintai) toward the 8 possible directions; **B.** Taisabaki – The circular movement. Within the Aikido tradition, the circular movement is performed with the aim of avoid sudden attacks and redirect the aggressive force toward circular trajectories; **C.** The Dynamic Sphere emerging from all the spirals and semi-spirals traced around the operative center of the practitioner, toward which the aggressive energy of the attack can be channeled and neutralized.

5. Summary and discussion

The importance of linking linguistic form and human experience is central to embodied views of language and cognition. According to embodiment theory, language comprehension, for example, requires mentally re-enacting, or simulating, specific embodied experience. Despite the debate concerning the extent to which this re-enactment requires the same low-level systems used in perception and action, there is strong evidence that embodiment is involved, indicating that language use (i.e., production, comprehension, and acquisition) requires that linguistic forms activate the same systems used in perception and action [Perniss et al., 2010].

For language to be effective and communication possible, shared mechanisms have to be activated. As we have shown in the introduction, sign languages are not totally arbitrary [Perniss, et al., 2010]. Metaphors are another example related to embodiment, and they are also not arbitrary. Lakoff and Johnson [1980] have systematically documented the non-arbitrary way in which metaphors are structured, and how they in turn structure thought. A large number of metaphors refer to the body and many more are inter-sensory (or synaesthetic). Furthermore, Ramachandran and Hubbard [2001] have found that synaesthetic metaphors (e.g., 'loud shirt') also respect the directionality seen in synaesthesia. That is, they are more frequent in one direction than the other (e.g., from the auditory to the visual modality), and have thus suggested that these rules are a result of strong anatomical constraints that permit certain types of cross-activation, but not others. On the other hand, given the current interest in bidirectionality in both metaphor [Goodblatt and Glicksohn, 2017] and synaesthesia [Anaki and Henik, 2017], one should not constrain future research because of such unidirectional assumptions. Being able to represent objects according to their motor function has a great advantage, as it allows the immediate production of an interaction schema that is appropriate to the object's use.

Behavioral evidence and artificial life simulations suggest that seeing objects or processing words referring to objects automatically activates motor actions. As Gombrich [1984] wrote, elements in a picture that determine aesthetical experience are "deeply involved in our biological heritage", although we are unable to give a conscious explanation to them [see also Ramachandran, 2004]. Thus, in addition to the motor system, what may be the related mediating mechanism linking the different examples?

According to Dietrich [2004], the explicit system is associated with verbal communication and conscious awareness (mediated by the frontal lobe and medial temporal lobe structures); while the implicit system is associated with skill-based knowledge (supported primarily by classically motor-related areas including the cerebellum) and is inaccessible to conscious awareness. Nevertheless, and luckily for us, information from the explicit and implicit knowledge base can be transferred from one system to the other, but solely through an active act: "Only through the circuitous route involving actual behavior can the explicit system come to embody an implicitly learned skill" ([Dietrich 2004], pp. 754).

In conclusion, although the current article is by no way a systematic review, it would like to suggest three main reflections: (1) objective art may exsist [Di Dio et al., 2007], in which (2) specific characteristics of objective art such as form (e.g. egg, square), proportion (e.g. the golden proportion) and frequency (e.g. 10,20 Hz) can produce a specific distinct neuronal and behavioral response [e.g. Ben-Soussan et al., 2017, under review,; Mauro et al., 2015]; (3) these effects may be mediated by the motor system. Related to this, Prinz has further claimed that "consciousness is about acting—it emerges through processes that make the world available to those systems that allow us to select behavioral means to our ends" ([Prinz, 2009], pp. 18). It is thus important to identify the stimuli which orient us to act in the direction we want. Understanding the specific characteristics of the stimuli may help architects and therapists, as well as parents and teachers, choose the best stimuli in order to voluntarily orient themselves and other people according to the inner state which they would like to achieve [Paoletti, 2008b, 2011].

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