Interdisciplinary implications on autism, savantism, Asperger syndrome and the biophysical picture representation: Thinking in pictures

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Abstract

It seems that neurotypical individuals (people without autism) have a hidden ability for savant-like skills, and these special abilities can be accessible via top-down cortical disinhibition of the left fronto-temporal lobe by repetitive transcranial magnetic stimulation (rTMS). It is well known that enhanced visual function in striate and extrastriate areas is a common character in autists, savants and subjects with Asperger syndrome. In addition, visual cortex not only processes visual signals but also is involved in the processing of mathematical thinking and auditory signals among them. Here we argue about the essential (and more ancient) role of picture representation over linguistic representation in ASD and that extraordinary savant-like skills are due to the explicit predominance of the right hemisphere (a malfunction of top-down control processes) accompanied with prevalence of lower level detailed visual information in the right hemisphere. Our recently presented novel biophysical picture representation hypothesis (also called as intrinsic biophysical virtual visual reality) about visual perception and imagery is also briefly described and linked to the predominance of lower level and detailed visual representation in the right hemisphere that may be a common character in autism, savantism, and Asperger syndrome.

Keywords: Autism, Savantism, Asperger syndrome, Biophysical pictures, Thinking in pictures

1. Introduction

Autism

Evidence is increasing that the neural mechanisms that underlie autism are due to atypical functional neural connectivity (either under- or over-connectivity) that generate atypical perceptions and information processing (Caron, Mottron, Berthiaume, & Dawson, 2006; Belmonte et al., 2004; Just, Cherkassky, Keller, & Minshew, 2004; Minshew & Williams, 2007). These atypical processes produce the peculiar behavioral and cognitive phenotype of autism that includes impaired social, emotional, (verbal and nonverbal) communication skills, repetitive behaviors, and restricted interests and activities. It is important to consider that children and adults with autism can exhibit different symptoms and these symptoms can range from mild to severe. Two persons with the same diagnosis can act completely different from one another. Because of the variety of severity and symptoms, the conditions are cooperatively known as autistic spectrum disorders (ASD).

People with autism have noticeable difficulties with the self-referential understanding of their emotions, self-awareness and cognitive processes (Lombardo et al., 2010). Namely, people with autism have an impaired intuition of their own mental states that may be caused by a malfunction of top-down control processes.

Although individuals with autism often exist in a world without abstract self-interpretation and self-understanding, they might also have superior visual and auditory (Bonnel, Mottron, Peretz, Trudel, Gallun, & Bonnel, 2003; O'riordan, 2004) sensations with subsequently stronger feed-forward processes. It seems that there is enhanced visual function in the right (early) visual areas in autism (Bertone, Mottron, Jelenic, & Faubert, 2005). Children with ASD appear to learn differently than other children and frequently have difficulty with spoken and written language expression.

Savants

Although other abilities are impaired, savants have a generally outstanding memory for specific categories including art, music, dates, mathematics, and pseudo-verbal skills (Treffert, 2005). These skills are accompanied by an exceptional ability to evoke detailed memories without meaning or understanding (Sacks, 2007). Moreover, they display a high incidence of synesthesia and absolute pitch.

The incidence rate of savant abilities in Hill's study (1978) was 1.4 per 1000 (0.14%) individuals in the intellectually-impaired population. In Rimland’s study (1978), which was based on parent reports, 531 of 5400 children with autism (9.8%) displayed special talents. The discrepancy between these studies suggests that there is a considerably greater incidence of savants in individuals with autism than in people with other intellectual impairments. In addition, savant skills can also emerge following an accident or as part of fronto-temporal dementia (Miller et al., 1998; Treffert, 2000) as well as suddenly and spontaneously (Miller, Boone, Cummings, Read, & Mishkin, 2000) in subjects who had no prior history for these abilities (Treffert, 2010). However, savantism is found more commonly among people with autism than any other neurological group (Howlin, Goode, Hutton, & Rutter, 2009). The majority of those with savantism also have autistic symptoms (Hermelin, 2002). However, savant abilities can be found in persons who do not meet the diagnostic criteria for ASD. Recently, Happe and Vital (2009) suggested that detail-focused cognitive style predisposes to talent, regardless of diagnostic group.

Artistic savants draw realistically and abstract expressionist savants have never been revealed. The IQ of autistic savant artists is below the average that suggests their talent is IQ independent (Drake & Winner, 2009). Autistic savant artists focus on details rather than the overall shapes. We do not find savants in true abstract expressionist, in philosophy, in novel writing (Drake & Winner, 2009). In contrast, unlike autistic savants, precocious realists do not use local drawing strategies and do not have below average IQs (Drake & Winner, 2009). The extraordinary abilities that are mainly observed in savants are associated with the right hemisphere (Tanguay, 1973; Rimland, 1978). Rimland discussed in detail the simultaneous nature of right-brain activity in savants with autism compared with the generally sequential nature of their left-brain activity.

2. All healthy people may have latent savant-like abilities

Recently, Snyder et al. (2003, 2006) and Snyder (2009) found that suppression of the left fronto-temporal lobe (LATL) by repetitive transcranial magnetic stimulation (rTMS) pulses temporarily elicited savant-like skills such as drawing, proofreading, numerosity or reducing false memories (Gallate, Chi, Ellwood, & Snyder, 2009) in normal volunteers. These findings are consistent with the notion that savants with autism have some atypical left-brain dysfunction.

According to Snyder et al. (2003) and Snyder (2009), all healthy people may have latent savant-like abilities that can be induced with low-frequency rTMS pulses to the left hemisphere of the brain. These rTMS pulses can temporarily deactivate the LATL (the dominant region in approximately 90% of right-handed people), which causes the less dominant right hemisphere to compensate. In turn, this compensation leads to the processing of savant-like tasks.

One might argue that not all individuals demonstrated improvements in these savant domains by rTMS suppressing of LATL (Snyder, Mulcahy, Taylor, Mitchell, Sachdev & Gandevia, 2003; Snyder, Bahramali, Hawker & Mitchell, 2006; Young, Ridding, & Morrell, 2004). However, rTMS suppressing of LATL can be similar to phosphene induction by transcranial magnetic stimulation (TMS) that is strongly dependent not only on the type of stimulation (electrical or magnetic stimulation), stimulation parameters, but also on the neural structure of individuals (Merabet, Theoret, & Pascual-Leone, 2003; Tehovnik, Slocum, Carvey, & Schiller, 2005). It is well established that given the stimulation intensity limits of TMS, not all individuals will experience phosphenes even at the maximum stimulation power (Cowey & Walsh, 2000; Boroojerdi et al., 2000; Kammer & Baumann; 2010). However, the mean V1 surface area is 2643 mm^2 in human, but the surface range is between 1986–3477 mm^2 (Adams, Sincich, & Horton, 2007). It means that there large differences between neural structure of individuals that basically influence outcomes of rTMS and TMS experiments.

It seems that all people may have a hidden, subconscious information process for savant-like skills but in healthy people these special abilities can be accessible by the top-down LATL cortical disinhibition.

3. Lower level and less-processed detailed visual information

Snyder et al. (2003) and Snyder (2009) proposed that savants have access to detailed, lower level and less-processed sensory information before it is assembled into higher order concepts.

However, some further experiments also suggest that transcranial magnetic stimulation (TMS) allows conscious access to subliminal and low-level visual representations. For instance, Halelamien et al. (2007) presented volunteers pictures of natural scenes and animals for 100 msec followed by TMS. They found that TMS stimulation shortly after image presentation induced the re-perception of defined forms that varied according to the content of the flashed image. In the most prominent cases, participants perceived photograph-like re-perception in portions of the display. Detailed visual information seems to remain encoded after visual perception. Moreover, TMS allows conscious access to these nascent low-level representations (Halelamien, Wu, & Shimojo, 2007; Wu, 2005; Wu, Halelamien, Hoeft, & Shimojo, 2007).

Silvanto et al. (2007) showed that after 30 sec visual adaptation to a uniform color, TMS induction of the occipital cortex could elicit phosphenes that took on the color qualities of the adapting color. For example, when volunteers adapted to the color green, they perceived a red negative afterimage in which the TMS induced green phosphenes. The negative afterimages lasted approximately 69 sec, and the so-called state-dependent phosphenes persisted for approximately 91 sec. It means that the information of perceived visual color (after 30 sec visual adaptation to a color) was not consciously represented for 91 sec in early retinotopic areas. This subliminal transitory representation of color briefly became conscious information via TMS stimulation.

Wu presented a colored, flashed disk to volunteers (2005). When the flashed disk disappeared after an approximate 2-sec pause, TMS induction was applied to participants' visual cortices who then re-perceived a portion of the flashed disk (Fig. 1). Some volunteers could re-perceive a portion of the flashed disk with photograph-like quality.

According to Harrison and Tong's (2009) fMRI experiments, early visual areas can maintain specific information concerning visual features in working memory for multiple seconds when no physical stimulus is present.

These experiments imply that the early visual areas are able to sustain detailed subliminal visual information for several seconds.

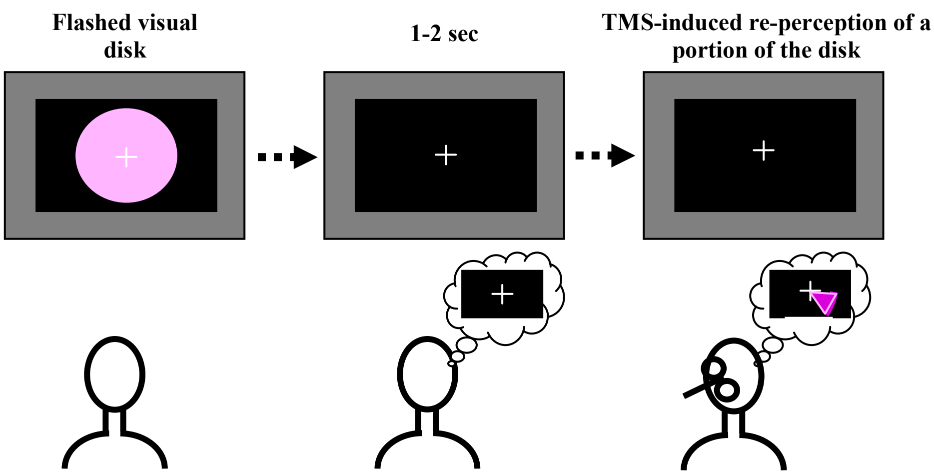

Fig. 1. *Schematic illustration about Wu's experiments (2005).*

4. Eidetic, visual, and spatial imagery

According to cognitive neurology and physiology experiments, children are thinking in eidetic pictures, but they gradually lose this ability while they learn to speak, read and write (Neisser, 1967). The recent results of Sahyoun et al. (2010) support that typically developing children preferentially use linguistically mediated pathways to think, while autistic cognition rely more on visuospatial processing networks.

One might argue that here we should make a clear distinction between eidetic, visual and spatial imagery while present our interdisciplinary implications. Eidetic images (or popularly called photographic memory) depend on external visual stimuli and are considered to be more detailed and longer lasting than visual images. Visual imagery allows a person to visualize objects or create a mental picture without external visual stimuli (it is commonly referred to as using "the mind's eye"). Various ideas emerged from statement that eidetic imagery is a fully separate internal physical process from visual imagery to claiming that eidetic imagery is a rare form of visual imagery (Giray, Altkin, Roodin, & Vaught, 1977; Haber, 1979). It is probable that visual imagery can be a range with non-eidetikers at one end and the excessive eidetikers at the other end.

However, we could see above in Halelamien et al. (2007) and Wu et al. (2007) experiments that shortly after image presentation TMS stimulation induced the re-perception of defined forms that varied according to the content of the flashed image and in the most prominent cases, voluntaries perceived photograph-like re-perception in portions of the display. It suggests that healthy adult people can perform photograph-like re-perception in portions of the display by TMS without ability of eidetic imagery. We should also consider that there are significant individual differences between the vividness of the visual imagery in the population (McKelvie & Rohrberg, 1978; Cui, Yang, Jeter, Montague, & Eagleman, 2007).

What about the distinction between visual and spatial imagery. Some investigators claim that visual and spatial imagery can be represented differently (Farah, Hammond, Levine, & Calvanio, 1988; Vannucci & Mazzoni 2009). However, according to the most recent fMRI studies by Golomb and Kanwisher (2011), "*..despite our subjective impression that visual information is spatiotopic, even in higher level visual cortex, object location continues to be represented in retinotopic coordinates*". In addition, Golomb and Kanwisher suggested that there is a not explicit hard-wired spatiotopic map in the brain and the spatiotopic object position can be computed not directly and continually reconstructed by each eye movement. It seems in many cases, we hardly make a clear distinction between eidetic, visual and spatial imagery.

5. Visual cortex activation during mathematical thinking and auditory signals

Mathematical thinking is a complex process that involves several areas of the brain, including the frontal and parietal lobes, angular gyrus, visual cortex, and Wernicke's and Broca's area. Other areas beyond these might also be involved in the mechanics thinking. Many studies have reported correlations between children's mathematical abilities and their visualization capabilities (Grobecker & De Lisi, 2000; Jordan, Levine, & Huttenlocher, 1995; Seethaler & Fuchs, 2006). There is close relation between visuospatial processes and numerical representation (Walsh, 2003). According to latest tDCS experiments, right-hemisphere stimulation helps people learn numerical symbols (Kadosh, Soskic, Iuculano, Kanai, & Walsh, 2010). In recent experiments by Frank and Barner (2012) reported that „*mental abacus is represented in visual working memory by splitting the abacus into a series of columns, each of which is independently stored as a unit with its own detailed substructure*".

Since many savants lack basic arithmetic skill (Murray, 2010), it is unlikely that calendar and lighting (lightning calculation is the ability to rapidly perform extraordinary feats of mental arithmetic) calculation ability can be mediated by intelligent calculation. It was suggested that savant calendar and lighting ability may be due to the conversion of abstract concepts to concrete entities (reification) (Murray, 2010; Eagleman, 2009). However, it is probable that intrinsic virtual visual representations (i.e. visual imagery) by early retinotopic areas can have essential roles in the conversion of abstract concepts to concrete entities. Namely, the emergent concrete entities may be nothing else than intrinsic virtual visual representations

The retinotopic visual cortex can be activated not only via a visual signal but also by auditory inputs in blind and sighted individuals (Buchel, Price, Frackowiak, & Friston, 1998; Roder, Stock, Bien, Neville, & Rosler, 2002; Voss, Gougoux, Zatorre, Lassonde, & Lepore, 2008; Wu, Weissman, Roberts, & Woldorff, 2007). According to recent electrophysiological and brain imaging experiments, visual, auditory, and somatosensory integration occurs at early stages of the visual cortical network (Giard & Peronnet, 1999; Macaluso, Frith, & Driver, 2000).

Because the visual cortex processes visual signals and is involved in the processing of mathematical thinking and auditory signals, when Snyder deactivated the left anterior temporal lobe by rTMS pulses, it made possible that the right (early) visual areas transiently work as superior conductors of inherent not conscious information processes.

6. Thinking in pictures: some simple illustrations about the elementary role of picture representation

Complex geometric forms are hardly represented by language-like processes. For example, when we memorize a complex chemical geometric formula like the heme molecule in red blood cells (Fig. 2) and later we recall and draw this complex pattern, it is hardly possible that "heme" word could represent this complex pattern in our brain. Rather, it is more likely that "heme" word, as an assigned signal/code to this complex visual stimulus, could initiate the retrieval of this pattern from our visual long-term memory.

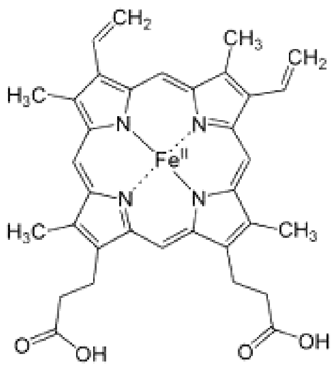

Fig. 2. *Heme structure*

Observe this beautiful Van Gogh painting (Fig. 3) with extremely detailed flower parts and various colors. We would be naive to think that these details were represented by tacit knowledge of Van Gogh. How many words would be needed to describe this scene? This task is probable impossible by words.

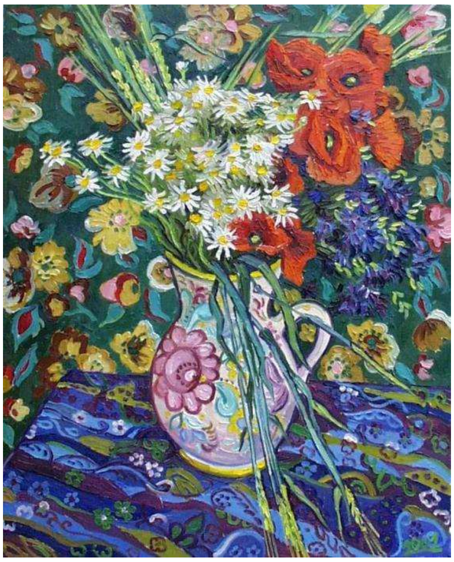

Fig. 3. *One of Vincent Van Gogh's most famous paintings, "Poppy Flowers"*

Stephen Wiltshire, a well-known person with autism, can draw detailed maps of Rome, Tokyo, New York, and so on from memory. This task is also impossible by words (i.e., this skill is possible only if the brain is able to use detailed picture representations). Wiltshire, who is British, was diagnosed with autism when he was child. He has been noted for his extraordinary visual memory that allows him to recreate enormous scenes in drawings that he saw only once. This video link (Fig. 4) shows his panorama of Tokyo after flying in a helicopter above the city one time.

Fig. 4. *Panorama drawing of Tokyo after taking one helicopter ride above the city via autistic Stephen Wiltshire.* http://www.youtube.com/watch?v=95L-zmIBGd4&feature=related

Animals can perform complex visual representations and are able to form concepts and make generalizations with visual pictures without language. A recent review by Collett and Collett (2002) in Nature Review in Neuroscience revealed that insects use visual thinking to navigate. The navigational strategies by ants and bees to reach a goal are similar to those of birds and mammals.

A guide dog for the blind is able to recognize an intersection in a strange city. According to Temple Grandin, (2002) *"Guide dog trainers teach the dog to generalize intersections by training the dog on many different types of interactions. If the dog was trained only on intersections with traffic lights, it may not know what to do at an intersection with no lights. Low functioning non-verbal people with autism have the same problem with generalizing. If the nonverbal person with autism is taught only at home to not run across the street, he or she will obey the rule at home but not at grandma's house. To generalize the non-verbal person with autism has to be taught not to run across the street at many different places."*

Humans are capable of perceiving various objects or events that have no corresponding words in our mental dictionary. New Guinea natives can discriminate green from blue but have only one word for both colors (Kay & Regier, 2006).

Different languages use different words to refer to concepts such as 'a tree' (Fig. 5). In contrast, anyone can understand a picture regardless of his or her spoken language. Linguistic descriptions of a tree in one language can be replaced with words from another, but the picture representation remains universal.

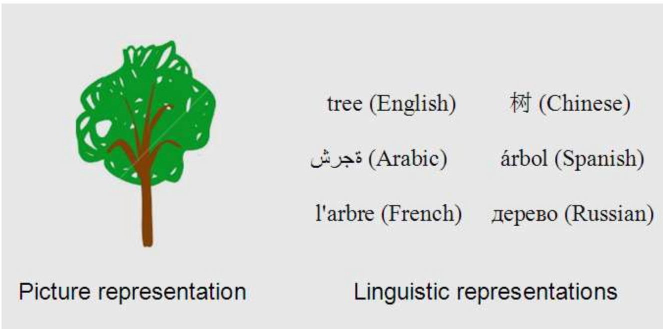

Fig. 5. *Linguistic descriptions of a tree can be replaced with numbers of words of different languages but picture representation remains universal.*

These simple examples might illustrate the more elementary role of picture representation over linguistic representation. Recently, Kunda and Goel (2011) presented their Thinking in pictures (Tip) hypothesis, and argued that "*certain individuals with autism may 'think visually' should be taken seriously as a cognitive model and receive more focused and sustained attention in behavioral and neurobiological experiments*". The Tip hypothesis was inspired by Temple Grandin's book (2006) and shows significant potential for explaining various autistic behaviors. In their paper, Kunda and Goel discuss several independent cognitive and neuroimaging studies on individuals with autism and note that all participants showed a strong bias toward visual representations and activity, which supports the Tip hypothesis.

7. Kosslyn's pictorial theory versus Pylyshyn's tacit knowledge explanation

There is a long-standing dispute in cognitive science regarding visual imagery between theories, i. e. between Kosslyn's depictive pictorial theory (1994) and Pylyshyn's tacit knowledge explanation (2003). Kosslyn's pictorial notion argues that mental imagery exploits top-down neural pathways to generate vision in the retinotopic striate and extrastriate areas. The visual system processes these representations as if they were visual percepts.

Pylyshyn claims (2003) that the activation of early visual areas during visual mental imagery is epiphenomenal. In addition, mental imagery is explained away by language-like representations and reduced to the tacit knowledge used in general thinking. Specifically, Pylyshyn asserts that we represent objects more abstractly in a symbolic/propositional format compared with the analogic or depictive format posited by pictorial theory.

Although increasing evidence shows that visual perception and imagery share common neural substrates, and that both visual perception and imagery induce activation in retinotopically organized striate and extrastriate areas (Cichy, Heinzle, & Haynes, 2011; Broggin, Savazzi, & Marzi, 2012; Lewis, Borst, & Kosslyn, 2011; Borst & Kosslyn, 2008; Stokes, Thompson, Cusack, & Duncan, 2009; Slotnick, 2004), the imagery debate is still unsolved, and there is no credible molecular biophysical mechanisms that meet the constraints and the available evidence on reverse hierarchies as applied to imagery and visual cognition.

8. The biophysical picture representation hypothesis

Recently, we presented a novel biophysical mechanism (Bókkon, 2009; Bókkon & D'Angiulli, 2009; Bókkon, Salari, & Tuszynski, 2011a,b) that is nothing more than a molecular and biophysical explanation of Kosslyn's pictorial theory. Namely, reflected photonic signals from an object are converted into electrical signals within the retina. These spike-related, retinotopic electrical signals create synchronized biophoton signals along classical axonal-dendritic pathways by redox reactions within the retinotopic V1 neurons. Small groups of visual neurons can operate as "visual pixels" that are appropriate to the topological distribution of the retina's photonic signals. As a result, we can obtain an inherent computational biophysical picture of the object created by biophotons in the retinotopic V1 (Fig. 6).

Our biophysical hypothesis (it is also called as intrinsic biophysical virtual visual reality, (Bókkon, 2009; Bókkon, & D'Angiulli, 2009)) not only revived Kosslyn's depictive theory (1994) and the *homunculus*, but has also argued that biophysical pictures can emerge in retinotopic visual regions. However, later an iterative model was presented to solve the *homunculus* problem (Bókkon, Salari, & Tuszynski, 2011a). That is, it proposed that during visual imagery, iterative feedforward and feedback processes can be interpreted in terms of a *homunculus* ("little man", mind's eye) looking at the biophysical picture representation. There is a possibility that biophysical pictures are a part of the re-entrant feedforward and feedback processes rather than separate from each other due to re-entry (Edelman, 1993). Accordingly, a separated *homunculus* looks at biophotonic picture representations can be a misleading view, because it can be achieved by matching processes (Bókkon, Salari, & Tuszynski, 2011a; Vimal, 2008, 2010; Perlovsky, 2009). The matching element is both in physical and mental aspects of feedforward and feedback signals. However, the visual *homunculus* can be reduced to a set of non-linear, biophysical, and iterative procedures.

The emergence of the iterative biophysical picture via biophotons in the retinotopic V1 and V2 visual areas and the interpretation of the emerged biophysical picture should be different, albeit closely connected processes (Bókkon, Salari, & Tuszynski, 2011a). The first process generates biophysical pictures (i.e., picture-like representations) in the visual V1 and V2 areas; the second process interprets language (i.e., language-like representations) via higher-order (i.e., tacit knowledge) associational areas.

In our biophysical model the long-term visual information is not stored as pictures but as epigenetic codes*. We are able to recognize objects because the same epigenetic processes are activated every time we see an object

This novel biophysical picture hypothesis did not claim to solve the secrets of consciousness but proposed that the evolution of higher levels of complexity made intrinsic biophysical picture representations of the external visual world possible by regulated redox and bioluminescent reactions in the early retinotopic visual system during visual perception and visual imagery (Bókkon, 2009; Bókkon, Salari, & Tuszynski, 2011a).

Recently, Sun, Wang and Dai (2010) revealed that biophotons can conduct along the neural fibers that can support the relevance of our biophysical picture hypothesis. It seems that biophotonic and bioelectronic activities are not independent biological events in the nervous system, and their synergistic action may play an important role in neural signal processes. Van Wijk et al. (2006) reported that the change of biophoton intensity was linked to meditative states in humans, suggesting that biophotons were elicited by spontaneous imagery.

Newly, Dotta, Saroka and Persinger (2012) and Dotta and Persinger (2011) performed some novel experiments. Specifically, volunteers who imagined a white light in a dark room were compared to those who engaged in simple casual thinking. The authors found significant increases in biophoton emissions (300%) from the right hemisphere but not from the left in the former participant group. Namely, there was a cognitive coupling with biophoton emission in the brain during subjective visual imagery. They emphasized that the emissions of biophotons are strongly correlated with the action potentials of axons. These results support our biophysical picture hypothesis that subjective visual imagery is strongly correlated with the release of biophotons and may be the actual experience of organized matrices of biophotons.

Epigenetic Long-term Memory

Increasing evidence indicates that epigenetic modifications (post-translational modifications of nuclear histon proteins and covalent modification of DNA) in neurons may be essential mechanisms for both the formation and storage of behavioral memory (Nelson & Monteggia, 2011). The latest studies suggest that epigenetic modulation of the genome is a necessary component for the formation of neuronal plasticity, associative learning and long-term memory (Feng, Fouse, & Fan, 2007; Reul & Chandramohan, 2007). Chromatin structure itself can represent a "memory" and allow for temporal integration of spaced signals or metaplasticity of synapses (Levenson & Sweatt, 2005). According to the epigenetic models, cognitive and memory functions are performed not only by neural networks but also by intrinsic processes of neurons (Arshavsky, 2006). Although the epigenetic model, which state that long-term memory is stored at the level of modified DNA molecules, has obtained little recognition, this model seems to be promising. However, the synaptic plasticity/neural networks model does not contradict the epigenetic model. Neuronal networks can act as continually variable information channels among neurons, but long-term memory has a chemical/epigenetic character in individual neurons. Therefore, the epigenetic model and network model can complement each other.

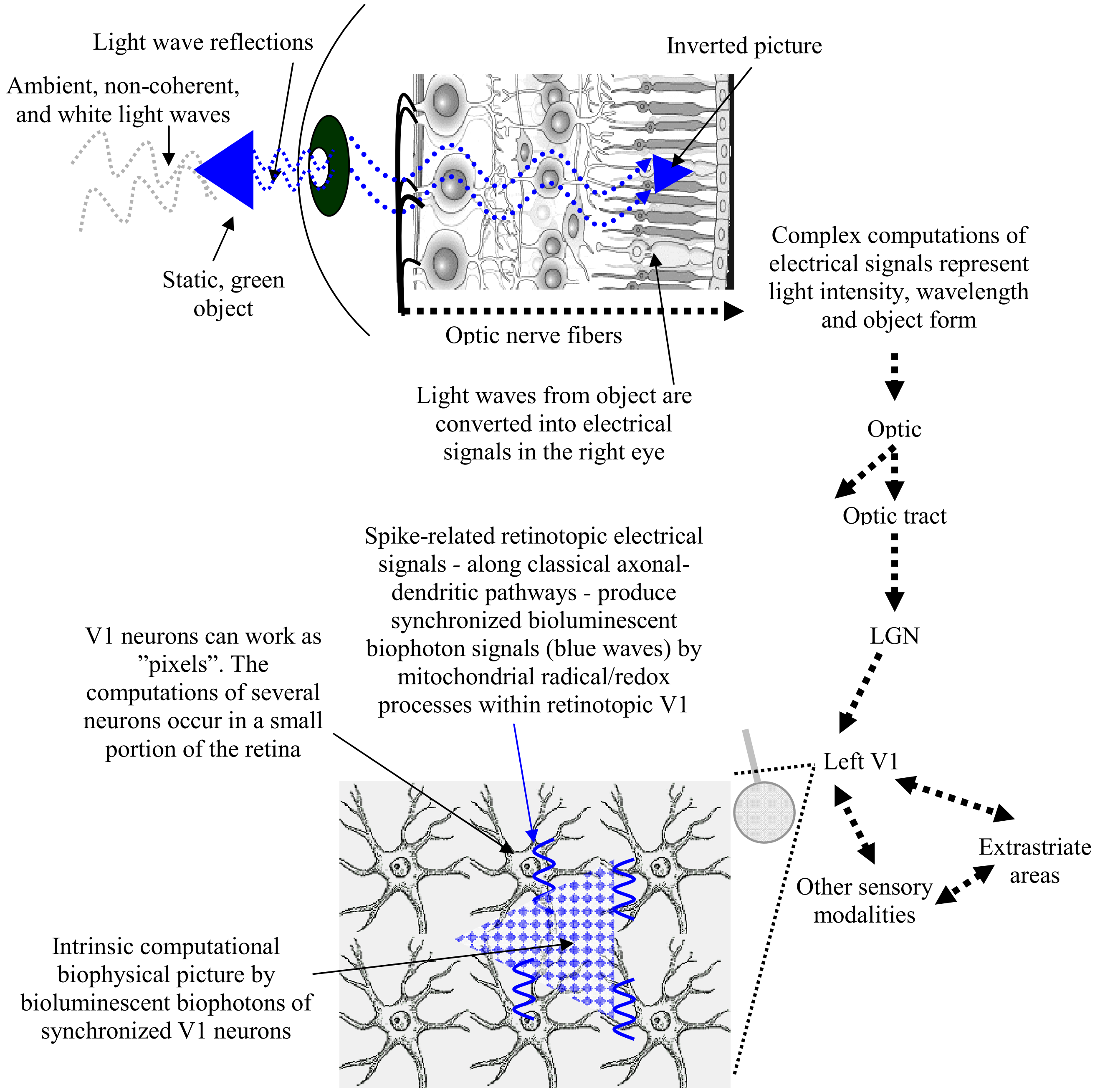

Fig. 6. *llustration about the emergence of biophysical picture representation (intrinsic biophysical virtual visual reality) during visual perception and imagery (Bókkon, 2009; Bókkon & D'Angiulli, 2009).* Photonic signals from an object are converted into electrical signals within the retina. These retinotopic electrical signals are conveyed to the V1 and transformed into regulated biophotons by mitochondrial redox processes inside the V1 neurons. In other words, spike-related, retinotopic electrical signals create synchronized biophoton signals along classical axonal-dendritic pathways via redox processes within the retinotopic V1 neurons. Small groups of visual neurons can operate as "visual pixels" that are appropriate to the topological distribution of the retina's photonic signals. As a result, we can obtain an inherent computational biophysical picture of the object created by biophotons in the retinotopic V1. Of course the long-term visual information is not stored as pictures but as epigenetic codes. We are able to recognize objects because the same epigenetic processes are activated every time we see an object. Thus, the representation stored in long-term visual memory will match the representation that is produced when we see the object again.

Top-down procedures regulate the epigenetically encoded, long-term visual information during visual processing. Subsequently, according to this retrieved epigenetic information, synchronized retinotopic neurons generate dynamic patterns of biophotons via redox reactions. Lastly, biophotons within the millions of synchronized neurons (Bókkon, Tuszynski, & Salari, 2011a) can produce biophysical pictures in the retinotopic visual area. It should be stressed that neural electrical signals are transmitted between neurons; however, biophotons are produced within retinotopic visual neurons.

9. Linking the biophysical picture representation hypothesis to ASD

One might ask why one should link the biophysical picture hypothesis to autism, savantism and Asperger syndrome.

First, enhanced visual function in the early visual areas are common characteristic of autism, savantism and Asperger syndrome (although with diverse and extended forms) as well as a more developed skill to access and manipulate visual mental representations (Caron, Mottron, Berthiaume, & Dawson, 2006; Soulières, Zeffiro, Girard, & Mottron, 2011; Sahyoun, Belliveau, & Mody, 2010). In addition, savants with autism or Asperger syndrome may access lower level and less-processed detailed sensory information before these data are assembled into higher order concepts. Sincich and Horton's (2005) observations support that lower level visual representations can be less-processed and detailed sensory information: "*…along with physiological and imaging studies, now make it likely that the visual attributes of color, form, and motion are not neatly segregated by V1 into different stripe compartments in V2".*

However, our described biophysical picture hypothesis (Bókkon, 2009; Bókkon, Tuszynski, Salari, 2011a) is also specific with regard to lower level retinotopic visual V1 and V2 areas (i.e., lower level detailed visual information). According to Baron-Cohen et al. (2009),"*the origins of the association between autism and talent begin at the sensory level, include excellent attention to detail and end with hyper-systemizing".* According to Bertone et al. (2005), „*However, our data show that atypical connectivity may be implicated initially within low-level visual areas rather than (or in addition to) between higher and lower visual areas (i.e. between V1 and specialized visual areas such as the superior temporal cortex or visual association areas). In this sense, atypical autistic visual information processing, and probably, visually related abnormal behaviour manifested by persons with autism, may be related to low-level perceptual differences to a greater extent than previously believed (Belmonte et al., 2004)*".

Second, we think that extreme detailed and realistic visual representation in early V1 and V2 areas cannot be guaranteed by mere electrical representations. Namely, objects in the visual field should be directly represented in the early retinotopic V1 and V2 areas by congruent patterns of biophotons originated from regulated free radical reactions. It means that this representation may be typically different from other representation forms (i.e., propositional descriptions) up to a point (at least at the level of V1 and V2 areas) in the stream of information processing.

Halelamien et al. (2007) and Wu et al. (2007) reported that shortly after a image presentation TMS induced the re-perception of defined forms that varied according to the content of the flashed image and in the most outstanding cases, subjects perceived photograph-like re-perception in portions of the display. It suggests that normal people can perform photograph-like re-perception in portions of the display by TMS without ability of eidetic imagery.

rTMS experiments by Snyder et al. (2003; 2006) suggest that savants have access to detailed, lower level and less-processed sensory information before it is assembled into higher order concepts, and all healthy people may have latent savant-like abilities. However, detailed and realistic visual representation may explicitly predominate in lower level visual areas in the right hemisphere in people with autistic, savant or Asperger syndrome. Besides the emergence of extraordinary skills can be linked to enhanced visual function in early V1 and V2 areas (a strong bias toward visual representations) that make it possible that abstract concepts can be converted into concrete representations (depictive reification).

However, we presume that the re-perception of defined forms and photograph-like re-perception in portions of the display by TMS as well as detailed and realistic visual representation in lower level visual areas in the right hemisphere in people with autistic, savant or Asperger syndrome were due to the congruent patterns of biophotons, i.e., to emergence of biophysical pictures in early V1 and V2 areas.

Third, Dotta, Saroka and Persinger (2012) and Dotta and Persinger (2011) revealed that biophoton emissions increased with 300% from the right hemisphere but not from the left during subjective visual imagery. Namely, there was a cognitive coupling with biophoton production in the brain during individual visual imagery. Besides, the emissions of biophotons are strongly correlated with the EEG activity and the action potentials of axons.

These outcomes can be related to experiments by Snyder et al. (2003, 2006) in which rTMS pulses deactivated the left anterior temporal lobe and healthy subjects could access to detailed lower level and less-processed visual information in their right hemisphere. In addition, there is enhanced visual function in the right (early) visual areas in autism (Bertone Mottron, Jelenic, & Faubert, 2005) and the extraordinary abilities that are mainly observed in savants are associated with the right hemisphere (Tanguay, 1973; Rimland, 1978). The enhanced visual function in the right (early) visual areas in autism and savants can also be related to experimental results by Dotta, Saroka and Persinger (2012) and Dotta and Persinger (2011).

Although a numbers of experiments are needed to strongly sustain our novel biophysical picture hypothesis in the future and link it to autism, savantism and Asperger syndrome, our biophysical picture idea may be promising in that it may present an integrated explanation about various visual related phenomena and malfunctions.

10. Some suggested experiments

- rTMS experiments by Snyder et al. (2003; 2006) were conducted with adults, while ASD (and most cases of savant skills) are mainly emerged in children. Thus, experiments suppressing LATL by rTMS pulses should also be performed with healthy children.
- The phosphene threshold is used as a measure of the visual cortical excitability. Induction of savant-like skills in healthy people by suppressing LATL by rTMS should be compared with phosphene threshold induced in healthy people and in people with ASD.
- In addition, it should be tested if induction of savant-like skills by low-frequency rTMS is depend on healthy subjects undergoing light deprivation.
- Dotta, Saroka and Persinger (2012) and Dotta and Persinger (2011) experiments support the biophysical picture notion and indicate a cognitive coupling with biophoton emission in the right hemisphere during subjective visual imagery. It should study and compare biophoton emissions from right and left hemispheres in autistics, savants, subjects with Asperger syndrome, and healthy people.
- In addition, studies should be done to see if rTMS suppressing of LATL may produce an increased biophoton emissions from right hemisphere in people with ASD and healthy people.

11. Summary

We have presented many arguments that visual processes may play key roles in autists, savants and subjects with Asperger syndrome. We have also seen that concrete and detailed visual representation can be a common and typical character in ASD.

In addition, experiments by Snyder et al. (2003; 2006) revealed, while rTMS pulses deactivated the left anterior temporal lobe, that savant-like abilities (drawing, proofreading, and numerosity) can be produced in healthy people. Snyder (2009) suggested that savants are able to use lower level and less-processed detailed sensory information from their right hemispheres before it is assembled into higher order concepts. However, we should reconsider the traditional view that the V1 is just a simple hub of visual sensory stimulation.

Because the visual areas of the brain can process visual signals as well as mathematical and auditory signals, Snyder's work (deactivating the left anterior temporal lobe via rTMS pulses) suggests that the right visual areas can become superior conductors of intrinsic, unconscious, mathematical or other kinds of sensory information, which led to the processing of savant-like tasks. However, several various atypical characteristics might be related to special, lower level visual functions.

Silvanto et al. (2007), Wu (2005) and Halelamien et al. (2007) TMS results also support the assumption that lower level visual representations are detailed and that perceived visual information can be not consciously maintained for some seconds in early visual regions.

Our novel biophysical picture representation hypothesis (Bókkon, 2009; Bókkon & D'Angiulli, 2009; Bókkon, Tuszynski, & Salari, 2011a,b) concerning visual perception and imagery was also briefly described. Namely, it states that objects in the visual field should be directly represented in the early V1 and V2 areas by congruent patterns of biophotons. It means that biophysical picture representation may be typically different from other representation forms (i.e., propositional descriptions) up to a point (at least at the level of V1 and V2 areas) in the stream of information processing.

We proposed that detailed and realistic visual representation in early V1 and V2 areas cannot be guaranteed by mere electrical representations. However, the biophysical picture concept may guarantee the detailed and realistic visual representation of objects in early retinotopic V1 and V2 areas by congruent patterns of regulated biophotons. For this reason, we linked our concept to the common characteristics (i.e. enhanced and detailed visual representation in early V1 and V2 areas in the right hemisphere) of people with autism, savantism and Asperger syndrome.

Recent experiments (Dotta, Saroka, & Persinger, 2012; Dotta & Persinger, 2011) suggest that there is a cognitive coupling with biophoton emission in the right hemisphere during subjective visual imagery and this biophoton emission strongly correlates with the EEG activity and the action potentials of axons. These experimental outcomes support our biophysical picture notion and may be related to Snyder et al. experiments as well as to enhanced visual functions in early visual regions in people with ASD.

Although numerous experiments are required to support the biophysical picture hypothesis and link it to ASD, our biophysical picture concept may be promising and may present integrated explanations about various visual related phenomena.

As Kunda and Goel (2011) suggested: "*certain individuals with autism may 'think visually' should be taken seriously as a cognitive model and receive more focused and sustained attention in behavioral and neurobiological experiments*".

Disclosure
The authors report no conflicts of interest. The authors alone are responsible for the content.

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