Neurophenomenology of Savant Syndrome

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ABSTRACT
Savant syndrome is an enigmatic disorder. It is characterized by cluster of outstanding mental ability in otherwise handicapped individuals. People with savant syndrome exhibit exceptional-extraordinary abilities and demonstrate some specific talents or particular skills along with developmental disabilities. Their profound and prodigious abilities are far in excess of what are considered normal. There is a paradoxical presence of special skills and distinguished disabilities. The documented savant skills include “lightning-speed” numerical calculation, calendrical calculation, musical savants (exceptional musical abilities, especially perfect pitch), artistic skills, hyperlexics (fast reading and understanding). Other types of talents and artistic skills involving three-dimensional drawing, map memory, poetry, painting, and sculpturing are also observed. The goal of this scientific article is to review savant syndrome, based on neurophenomenology framework and recent findings.

Keywords: Savant syndrome, neurophenomenology, neurocognitive models

INTRODUCTION

Savant is person with obvious mental retardation who is capable of performing in sharply circumscribed areas (e.g. arithmetic, calendar calculating) at a remarkably high level.1 Savant syndrome is a constellation of symptoms or behaviors, a collection of characteristics or conditions that is superimposed and grafted on to some underlying disabilities.2-7 It is not a disorder or disease.8

It is characterized by certain spectacular skill(s) or prodigious intellectual gifts in a specific area (i.e.: mathematical, musical, artistic, mechanical abilities, etc), subnormal intelligence, massive memory, different disability/handicap or sometimes with severely limited emotional range.6,7 Formerly, savant syndrome is known as idiot savant, first coined by Down.9

Type
Savant syndrome has been differentiated into two kinds, i.e.:10
1. ‘Prodigious’ savants, i.e.: individuals whose talents and abilities are exceptional and well beyond the range of normal functioning in relation to both their overall level of functioning and the general population.
2. ‘Talented’ savants, i.e.: individuals showing outstanding skills in comparison with their overall levels of functioning.

Both prodigious and talented savants are most frequently reported as autism spectrum disorder (ASD).

Epidemiology
Savant syndrome occurs in less than 1% of the intellectually disabled population.11
The incidence of savant syndrome is 10% in autistic disorder (531 savant in 5400 children with autism). If the presence of savant syndrome is not limited to autism, it is estimated to be 1-2 in 200. In population with mental retardation, the incidence of savant skills was 1:2000. The prevalence of savant syndrome is 1.4 per 1000. Ratio males: females is 6:1. At present, there are perhaps fewer than 100 known prodigious savants living worldwide.

“SAVANT” as Clinical Portraits, Early Detection and Identification

The clinical portraits of savant syndrome can be memorized easily by mnemonics “SAVANT” below (Table 1). It can also be used as the fastest way in early detection or identification of savant syndrome.

### Specific Savant Skills, Abilities, or Expertise

Savant skills are often referred to the existence of extraordinary talent in art, music, math, calendar calculation, or memory. Actually, savant skills have multispecific areas. They are certain arithmetic-mathematical skills, art (visual arts; particularly drawing), coordination skills, computation-calculation, or musical performance, prime number derivation, perceptual expertise may be implicated in the choice of special ability in savant syndrome.

### Variations and Anomalies

There are a lot of variation that can be observed in person with savant syndrome. Variations are in intelligences and maturity of the specific areas of savant skills above are mainly categorized into three spectra, i.e.: 1. Splinter skills (e.g.: memorization of music and historical facts trivia) 2. Talented savants (e.g.: having special abilities but cognitively impaired) 3. Prodigious savant (e.g.: having special skill(s) which is so amazing, astonishing, outstanding, and spectacular).

### Autism

Some of savants have autism. The autistic savants have a tendency to have repetitive behaviour and/or preoccupations with a restricted area of interest. They also show interest in one specific topic. Not all persons with savant syndrome have autistic disorder and vice versa. Increased perceptual expertise may be implicated in the choice of special ability in savant syndrome. Therefore, autism is sometimes superimposed in savant syndrome.
It is concluded that there are a lot of variations and anomalies in specific regions in the brain of person with savant syndrome.

**Veridical Mapping Mechanism**
Savant abilities share the same structure-developmental course. They represent related ways by which the perceptual brain deals with objective structures under different conditions. These different phenomena develop through a veridical mapping (VM) mechanism whereby perceptual information is coupled with homological data drawn from isomorphic structures.37

VM is a peculiar mechanism that can expound the higher incidence of savant abilities especially in autism. It has also been hypothesized in an effort to account for the role of perception in the high prevalence of savant syndrome, particularly in autism.17,38

The prevalence of savant abilities among persons with autism range from 1/100 to 1/3 or higher.17,39

The mechanisms involved in savant abilities initially entail VM between perceptually presented isomorphic patterns. It is *veridical* in the sense that the mapping emerges when there is a sufficient level of similarity between at least two structures. The mapping involves the coupling of homologue elements of recurrent isomorphic patterns, and is the basic mechanism for structure detection.40

The seven basic components in savant abilities based on VM are:37
1. Savant abilities involve materials with a high density of isomorphisms.
2. Savant abilities are based on the early implicit within- and between-code mapping among large isomorphic structures.
3. Material and operations involved in a domain-specific ability depend on episodic exposure to this material.
4. Superior performance of savants on domain-relevant tasks results from a combination of enhanced perception and expertise.
5. Savant performance involves non-strategic recall or redintegration.
6. Understanding of linguistic codes is achieved in perceptual, non-linguistic ways.
7. During development period, savant abilities become gradually more explicit, and merge with typical reasoning/algorithmic processes, resulting in a unique combination of perceptual and abstract structure.

**Neurological-neurodevelopmental Disorders-disability**
Neurological and/or neurodevelopmental disorders and any disability are a possibility and susceptibility in person with savant syndrome. It is estimated 50% of persons with savant syndrome have developmental disability, mental retardation, or other CNS injury/disease. Another 50% have autistic disorder.19

There is at least one specific disability in person with savant syndrome, i.e.: autism, brain injury, cerebral palsy, congenital syphilis, delayed language, depression, echolalia, encephalitis, epilepsy, high fever at age one, language delay, language disorder, language impairment, left hemispherectomy, left side convulsions, Marfan syndrome, mentally handicapped, premature, meningitis, pervasive development disorder, rubella “autistic”, schizophrenia, slow speech, socially obtuse, “limited” speech, Tourette syndrome, very distracted, visual impairment, unspecified.41-46

**Talents or Talented**
A person with savant syndrome can have one or some talents in specific area, i.e.: art, music, calendrical and numerical calculation, linguistic and language-related.47 Savants aren’t gifted. Someone can be gifted without necessarily being talented (as with the case of underachievers), but not vice versa.48

The documented savant skills include “lightning-speed” numerical calculation, calendrical calculation, musical savants (exceptional musical abilities, especially perfect pitch), artistic skills, and hyperlexics (fast reading and understanding). Other types of talents and artistic skills involving three-dimensional drawing, map memory, poetry, painting, and sculpturing are also observed. Savant talent has traditionally involved exceptional memory, and sometimes for peculiar material (e.g. bus routes, telephone directories, etc). People with savant syndrome exhibit exceptional-extraordinary abilities and demonstrate some specific talents or particular skills with developmental disabilities. Their profound and prodigious abilities are far in excess of what are considered normal. There is a paradoxical presence of special skills and distinguished disabilities.

**Cognitive Models**
There are three current cognitive models of savant syndrome:55

1. A hypermnesic model.15
This model suggests that savant skills develop from existing or dormant cognitive functions (i.e.: memory). Recent researches based on neuropsychological examinations imply that savant individuals use problem-solving strategy fairly different from a non-autistic one.

2. A paradoxical functional facilitation model.55
This model offers possible explanations on how pathological states in the brain lead to development of prodigious skills. This model emphasizes the role of reciprocal inhibitory interaction among adjacent or distant cortical regions, especially that of the prefrontal cortex and the posterior regions of the brain. This model is adjacent and related to the paradoxical cognitive phenomena.

Five forms of the paradoxical cognitive phenomena:56
(a) Enhanced cognitive performance of neurological patients vis-à-vis neurologically intact individuals (lesion facilitation).56
(b) Alleviation or restoration to normal of a particular cognitive deficit following the occurrence of a second brain lesion (double-hit recovery).
(c) 'Hinder–help effects', a variable that produces facilitation or detriment of performance in healthy participant’s results in opposite effects.
(d) Anomalies in the usual relationship between the presence/size of a brain lesion and the degree of cognitive deficit (lesion–load paradox).
(e) There may appear to be direct or indirect benefits for long-term neurological outcome as the result of specific cognitive deficits being present (‘paradoxical positive outcome’).

3. Autistic models based on weak central coherence theory.
This model focuses on how savant skills emerge from an autistic brain. Central coherence theory refers to the common tendency to process incoming information globally and in context, thus aiding human beings to make sense and understand structure and meaning. This tendency operates at the expense of attention to details.

**Differential Diagnosis**
Clinicians, general practitioners, and practitioners should be careful in establishing savant syndrome as a certain diagnosis. Patients are recommended to undergo specific genetic examination. Specific skills are also reported in genetic disorders, such as: Prader–Willi syndrome (memory-visuospatial skills), Smith–Magenis syndrome (computing-memory), Williams syndrome (music-memory).

**SUMMARY**
Savant syndrome is an enigma among the great mysteries of cognitive neuroscience. It has great challenges for new discoveries that could reveal greater depths of the concept of genius from human mind.


50. Grandin T. Thinking in pictures: And other reports from my life with autism.


