BRANCHING OUT FROM AUTISTIC SAVANTISM: IDENTFYING AND DEFINING AUTISTIC CRYPTO-SAVANTISM IN INDIVIDUALS WITH NON-VERBAL/VERBAL LOW-FUNCTIONING AUTISM

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Abstract:

With the escalating prevalence of autism spectrum disorder, there is also an increasing number of autistic savants, who besides their autistic disorder, also possess both extraordinary special abilities and remarkable memory. Within this group of autistic savants, there is a hidden category of low-functioning individuals with autism first identified by Rimland (1990) as *autistic crypto-savants* – unable to communicate (with little or no speech) but possess savant talents hidden, or remained secret, and are unknown to those around them. The existence of such individuals cannot be denied unless proven otherwise. Hence, in this paper the authors hope to focus on two key issues: firstly, the need to fully understand and explain their aetiologies; and secondly, with no conclusions drawn currently, the need to fully explore the ramifications of autistic crypto-savants. The term *autistic crypto-savantism* and its definition, like the broader term autism, has evolved over the past decades due to better understanding and/or new discoveries. Hence, the authors of this paper strongly feel that there is a need to re-examine the existence of autistic crypto-savantism within the wider context of autistic savantism and current definition of autism.

Keywords: autism, autistic crypto-savantism, autistic savantism, low-functioning autism

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Introduction

There have been numerous definitions of autism in the literature review over the past decades. Our early understanding of autism, or autistic disorder, comes from Kanner (1943) and Asperger (1944). Since then, numerous researchers have studied autism, from aetiologies, behavioural, cognitive, neurophysiological, to neuropsychological aspects till now. The diagnostic criteria for autism has also been changing since the publication of the Diagnostic and Statistical Manual of Mental Disorders (DSM) during 1980-2013.

The prevalence of autism is escalating and this is a worrying trend for educators and parents with more males than females affected with the disorder. Perhaps better awareness and early screening for individuals, who are suspected or at-risk, are the contributing factors to the high prevalence rate. Hence, with early screening and the high incidence rate, the protocol of autism assessment as well as its treatment has also been changing over the years.

Research has shown that within this population of autistic individuals, there is a small percentage of them who exhibit exceptional abilities and skills, or it can be hidden, together with remarkable memory (Edelson, 1995; Miller, 19998; Rimland, 1978, 1990; Treffert, 2000, 2005, 2009), either with or without intellectual ability. Such individuals are seen as *autistic savants*, or having s*avant syndrome*, or identified as *autistic crypto-savants*, with the latter often being neglected in the eyes of the public. The authors of this paper felt there is a need to identify this latter group of hidden talented individuals so that their islets of abilities can be fully maximized and be made known publicly and help them become contributing members of their community. As such, the authors strongly feel that there is a need to include autistic savant and autistic crypto-savant in the current definition of autism, which the second author has already reiterated elsewhere (see Chia, 2008, 2012).

1. What is Autism?

In Greek, the term *autism* denotes "autos", which means "self". The two most prominent figures in the field of autism are Dr Leo Kanner and Dr Hans Asperger. Kanner (1943) in his seminal paper used "early infantile autism" to denote autism which was a disorder distinct from childhood schizophrenia. He characterised autism that display a triad of impairments of (1) impaired social interaction, (2) impaired verbal communication, and (3) lack of imaginative play. Unbeknownst to him, a year after Kanner published his paper, Asperger (1944) in his paper described children with

similar traits except that his subjects were of higher IQs with precocious language skills, and the condition has been known as Asperger Syndrome. Today, the term *autism* is synonymous with autistic disorder and also refers to mean Autism Spectrum Disorder (ASD) with varying degree of severity that range from mild, moderate, severe to profound.

Globally, the prevalence of autism is escalating and this is a worrying trend for both parents and educators. The prevalence is estimated at 1 in 68 births occurring in all racial, ethic, and socioeconomic groups in U.S. (Centers for Disease Control and Prevention/CDC, 2014). In Singapore, it is difficult to provide a statistical figure on the actual number of persons with autism as there have been no official or accurate studies conducted to establish the exact prevalence rates across all age groups and genders. Based on prevalence rates worldwide, the figure is estimated in the range of 1% of the total population with about more than the estimated number of 200 cases of newly diagnosed children with autism annually.

Over the past decades, the diagnostic criteria for autism or ASD, has been changing. The most commonly and widely used definition of ASD in the autism research is taken from the Diagnostic and Statistical Manual (DSM). Diagnostically, ASD is a neurodevelopmental disorder that is also known as Pervasive Developmental Disorder (PDD), which consists of five clinical subtypes: the early infantile low-functioning autism or autistic disorder (also known as Kanner Syndrome), the high-functioning autism known as Asperger Syndrome, the childhood disintegrative disorder (also known as Heller Syndrome), Rett Syndrome, and the atypical autism which is also known as PDD not otherwise specified (PDD-NOS). ASD involves a combination of qualitative impairments in reciprocal social interaction, communication, and repetitive, restricted, and stereotyped patterns of behaviour, with age onset before or at 3 years old (DSM-IV-TR, American Psychiatric Association, 2000). However, with the new criteria under DSM-5, it states that an individual must manifest three deficits in, (1) social interaction, (2) communication and (3) at least two repetitive behaviours (American Psychiatric Association, 2013) for a diagnosis of autism.

While the DSM-5 is used widely by professionals, some practitioners used the Educator's Diagnostic Manual (EDM) of Disabilities and Disorders (Pierangelo & Giuliani, 2007), published by the American Academy of Special Education Professionals in their practice. According to the EDM under the Individuals with Disabilities Education Improvement Act 2004, autism is defined as:

> *"a developmental disability significantly affecting verbal and*
> *nonverbal communication and social interaction, usually evident*

before age 3 that adversely affects a child's educational performance. Other characteristics often associated with autism are engagement in repetitive activities and stereotyped movements, resistance to environmental change or change in daily routines, and unusual responses to sensory experiences. The term does not apply if a child's educational performance is adversely affected because the child has an emotional disturbance'' [34 C.F.R. 3000.7(c)(1)].

In addition, EDM provides a comprehensive overview of the disorder under its code AU (Level I) and further identifies eight specific disorders for this classification (Level II) as shown in Table 1 below.

Table 1: EDM Level 1-AU Classification with the Level 2 Categories

AU1.00 Asperger Syndrome
AU2.00 Autistic Disorder *(also known as Kanner Syndrome)*
AU3.00 Childhood Disintegrative Disorder *(also known as Heller Syndrome)*
AU4.00 High-Functioning Autism
AU5.00 Hyperlexia
AU6.00 Multiplex Developmental Disorder
AU7.00 Rett Syndrome
AU8.00 Other Types of Autism (to be designated specifically)

* Words in italic are the authors' additions.

The EDM uses a five-level diagnostic coding system to help professionals in the special needs sector to understand how ASD affects a child's educational performance and how the case management team can decide the extent to which the child needs support in terms of modifications, related services, assistive technology, classroom accommodations and a restrictive educational program outside the regular classroom.

2. The Diagnostic Protocol for Autism

When a child is suspected to have autism, he/she needs to undergo three level of screening protocol as suggested by Bishop, Luyster, Richler, and Lord (2008) as shown in Table 2 below.

Table 2: Three-level Screening Protocol for Autism

Level	Types of Tests
1	• Checklist for Autism in Toddlers (CHAT)
	• Modified Checklist for Autism in Toddlers Revised (MCHAT-R)
	• Early Screening for Autistic Traits (ESAT)
	• Communication & Symbolic Behavior Scale–Developmental Profile
2	• Social Communication Questionnaire (SCQ)
	• Screening Test for Autism in Two-Years-Olds (STAT)
	• Childhood Autism Rating Scale (CARS)
	• Gilliam Autism Rating Scale (GARS)
3	• Autism Diagnostic Interview – Revised (ADI-R)
	• Autism Diagnostic Observation Schedule-2nd Edition (ADOS-2)

Note: Levels 1 & 2: Screening Tests; Level 3: Standardised Diagnostic Tests

At Level 1 screening, professionals typically use the reports of parents and caregivers to measure broad developmental constructs that is suggestive of ASD. Typically, they are easy and quick to administer and interpret. In contrast to Level 1, Level 2 screening focuses on high probability of ASD and it is important as it allows practitioners to discriminate developmental disabilities from other disorders so as to pinpoint the specific developmental conditions (Bishop et al., 2008). Commonly used screening tests are the SCQ, STAT, CARS, and/or GARS as shown in Table 1 above. The third level of screening is for children who score below an established cut-off score on Level 2 screening and also exhibit unusual developmental patterns. In this case, they should receive a more in-depth diagnosis using standardised and validated tools such as ADR-I and/or ADOS-2 to confirm if the child is in the category of autism or ASD.

Apart from the above tests for ASD, there are also other standardized assessment tools required to measure the innate abilities (intellectual functioning) for individuals with speech, without speech, sensory perceptual motor behaviour, level of functioning skills, speech, language & communication, and social behavioural profiles. These standardized assessment tools are shown in Table 3 below.

Table 3: Levels of Standardized Assessment Tools for ASD

Level	Types of Standardized Assessment Test
1A (innate abilities with speech)	WPPSI-IV, WISC-V, SB-5
1B (innate abilities without speech)	LIPS-4, CTONI-2, TONI-4, Raven Progressive Matrices
2 (sensory perceptual motor behavior)	Child Sensory Profile-2
3A (level of functioning skills)	VABS-II, LEAF Scale, BRIEF
3B (speech, language & communication)	CELF-IV, OWLS-2
4 (social behavioral profiles)	Social Responsiveness Scale
5 (autism affirmative measure)	ADOS with/without ADI-R

Note: WPPSI-IV: Wechsler Preschool and Primary Scale of Intelligence-4th edition; WISC-V: Wechsler Intelligence Scale for Children-5th edition; SB-5: Stanford-Binet Intelligence Scales-5th edition; LIPS-4: The Lindamood Phoneme Sequencing Program for Reading, Spelling, and Speech-4th edition; CTONI-2:Comprehensive Test of Nonverbal Intelligence-2nd edition; TONI-4: Test of Nonverbal Intelligence-4th edition; VABS-II: Vineland Adaptive Behaviour Scales-2nd edition; LEAF Scale: Learning, Executive and Attention Functioning ;BRIEF: Behaviour Rating Inventory of Executive Function; CELF-IV: Clinical Evaluation of Language Fundamentals-4th edition; OWLS-2:Oral and Written Language Scales-2nd edition

3. Differentiating Autistic Savantism from High-Functioning Autism without Savantism

In the EDM (Pierangelo & Giuliani, 2007), high-functioning autism (HFA) is defined as *"people with autism who have average or above-average intelligence and can function in typical settings, such as school or the workplace, with minimal assistance. The diagnostic symptoms stated that children with HFA are much more efficient with expressive and receptive speech, less likely to suffer from epilepsy, and have IQ scores of 71 or above"* (p.258).

There has been queries on the differentiation between HFA and Asperger syndrome (AS) as it has been noted that the speech development in some individuals with AS did not develop normally whereas people with HFA showed the same high level of cognitive and adaptive skills (McLaughlin-Cheng, 1998). Intellectually, the full-scale IQ (FSIQ) of children with HFAD falls in the range between 50-85 (borderline and average) while the FSIQ of those with AS falls in the range between 90-120 (average and high average) (McLaughlin-Cheng, 1998). In the domain of language development, children with HFAD often displayed delayed and disordered language and cognitive abilities, whereas individuals with AS commonly develop language normally with the manifestation in appropriate grammar, excellent vocabulary, and typical comprehension (McLaughlin-Cheng, 1998). Socially, children with HFAD have

impaired social skills where they appeared to be aloof and indifferent while those with AS displayed bizarre behaviors that are associated to their own deep narrow interest.

While savant syndrome is closely related with ASD, many or most individuals with autism do not possess savant abilities (Treffert, 2009; Rimland, 1978). A recent study by Bennett and Heaton (2017) found that individuals with autistic savants manifested superior working memory capacity as evident in the forward and backward Digit Span subtest under the WISC-IV. In addition, they also exhibited excellent fluid intelligence in the areas of abstract reasoning when performing the Block Design subtest and Raven's Matrices tests.

According to Exkorn (2005), "[W]hile it is true that "the majority of autistic savants have *low IQs* (hence, mentally retarded), there are some autistic savants who are *highly intelligent*" (p.69). Exkorn (2005) has identified three types of savant skills: (1) splinter skills – the most common type with obsessive preoccupations with and memorization of trivia and obscure information (e.g., license plate numbers of vehicles); (2) talented skills – autistic savants with talented skills that are more highly developed and specialized (e.g., art, musical, mathematical calculation); and (3) prodigious skills – the rarest where savants possessed remarkable skills even if they were to occur in non-handicapped individuals

Differentiating individuals with autistic savantism from HFA without savantism requires a differential diagnosis approach. The authors of this paper suggested encompassing a comprehensive assessment that comprises of using a clinical, cognitive, behavioural, sensorial, socio-communicative phenotype as described earlier (see Table 3). Prior to these diagnostic assessments, an initial screening has to be conducted for individuals suspected with autistic savantism and HFA without savantism by using the three-level screening protocol for autism as outlined in Table 2.

4. Differentiating Autism from Intellectual Disability

Studies (e.g., Ambrosini, 2000; Leyfer, Folstein, Bacalman et al., 2006) have shown that ASD have psychiatric comorbidities in which the wide IQ range and communication impairment make diagnosis challenging. Since autism is on a spectrum with severity that ranges from mild, moderate, severe to profound, how do we then differentiate autism from intellectual disability?

Autism can co-exist with other neurodevelopmental disorders such as specific learning disability, Tourette's syndrome, Attention Deficit Hyperactivity Disorder, language disorder, and Intellectual Disability (ID). It is beyond the scope of this paper

to discuss all the co-existing disorders with ASD here. The authors have chosen to focus on the differentiation of autism from ID.

According to Volkmar and Lord (1999), the majority of individuals with autism has intellectual impairment. Previously, ID is known as mental retardation. Individuals with ID have deficits in intellectual and adaptive functioning, generally before the age of 18 (Schalock et al. 2010). According to the report from CDC (2014), about 38% of children with ASD had ID. Among this group, an estimated about 24% had IQ in the borderline range (IQ of 71 to 85) and 38% had average or above average IQ (over 85). The report also indicated a higher percentage of females with ASD had ID compared with males, i.e., an estimate 46% of females as compared with 37% of males.

ASD and ID are two separate neurological conditions that share some similar symptoms. This may explain why parents sometimes have problems getting a correct diagnosis when a child has severe autism or ID because of shared characteristics that deal with developmental delays, communication problems, learning difficulties and self-help skills. While ASD has been defined by DSM and EDM mentioned earlier in this paper, the DSM-5 looks at how the impairments of general mental ability impact the adaptive functioning in the following three domains that determine how well an individual is coping with daily activities in the identification of ID (American Psychiatric Association, 2013, p.1):

(1) Conceptual domain: skills in language, reading, writing, mathematics, reasoning, knowledge, and memory;
(2) Social domain: empathy, social judgment, interpersonal communication skills, befriending and similar capacities; and
(3) Practical domain: self-management skills (e.g., personal care, job responsibilities, money management, recreation, and organizing school and work tasks).

Research evidence has shown that ID is more likely to be present in children with more severe and/or profound ASD symptoms than in those with milder manifestations (Dykens & Lense, 2011). In their study, it was found that the IQ levels vary substantially across diagnoses under the umbrella of PDD (i.e., ASD) and with a more severe symptomatology that is related to lower cognitive scores. Another longitudinal study by Gotham, Pickles, and Lord (2012) using 345 participants discovered that individuals with more severe autistic symptomatology had lower IQ and this led to the conclusion that autism characteristics and cognitive functioning are not entirely independent features.

Researchers are still attempting to determine if there is a common genetic link between ID and ASD. Certain genetic syndromes (e.g., Fragile X, Rett, Down, phenylketonuria, and Angelman) are related to severe ID and also have a high incidence of ASD. However, other research has shown that ID is associated with a high number of deletions within an individual's genetic code, whereas ASD is associated instead with a high number of duplications (Vivanti et al., 2013). Regardless of the possibility of a causal connection, it is recognized that individuals with ASD and those with ID share common struggles, particularly with respect to social and communication skills, which are necessary components of the ASD diagnosis. When an individual is diagnosed with ASD and ID, it is known as autistic spectrum phenotype.

5. Autistic Savantism

The term "Savant" is derived from a French word, "Savoir", which literally means "*a learned person*". In 1789, Dr. Benjamin Rush, described the remarkable calculating ability of Thomas Fuller by asking him: How many seconds a person had lived who was seventy years, seventeen days, and twelve hours old? Fuller thought for only 90 seconds, then gave the correct answer of 22,210,500,800 seconds, even correcting for the seventeen leap years involved.

A century later, the term *idiot savant* was first coined in 1887 by a British physician, John Langdon Haydon Down (b.1828-d.1896), after whom the genetic disorder Down syndrome was named. At that time, doctors actually used the word *idiot* to describe someone whose IQ was below a certain level. Today, the term *autistic savant* has mostly replaced the harsh-sounding *idiot savant*, although others sometimes prefer the more generic *savant syndrome* because not every savant is autistic. In 1995, Edelson (1995) refers *autistic savant* strictly to individuals with autism who possessed extraordinary skills not manifested by most persons. One of the influential researchers in the field of autistic savant is Dr Darold Treffert, a psychiatrist by professional training. He has been studying savant syndrome for more than 50 years and has defined the condition as:

> "*rare but extraordinary condition in which individuals with serious mental disabilities, including autistic disorder, have some "islands of genius" that stands in marked incongruous contrast to the overall handicap" (Treffert, 2000, p.15).*

Treffert (2005) further described that there are three combinations that make up autistic savant: (1) autistic disorder, (2) extraordinary special abilities, and (3) remarkable memory. Over the years, different terms have been used to denote autistic savantism in the field of research as shown in Table 4 below.

Table 4: Terms used in Autistic Savants

Researcher/Year	Term used
Down (1887)	Idiot savantism
Charness et al. (1988)	Mono savantism
Treffert (1989)	Savant syndrome
Rimland (1990)	Autistic crypto-savant
Edelson (1995)	Autistic savantism
Chia (2012)	Autistic savant syndrome

According to Treffert (2010), not all savants are autistic, and not all autistic persons are savants. The autistic savants are often associated with left-brain dysfunction and right-brain compensation. The right brain of autistic savants is often highly skilled in the areas of memory, music, calendar calculation, mathematics abilities, and artistic skills (Treffert, 2000; 2005). Most autistic savants are associated with superior visual-discrimination abilities (O'Riordan et al., 2001; O'Riordan, 2004). In a sample of 17 savant males and 19 non-savant males between 8 years and 12 years 9 months with a diagnosis of ASD, and comparing with 17 typically developing children, Bennett and Heaton (2017) found that savants displayed superior ability in two subtests of the WISC-IV: (1) Block Design (a skill that requires visual-spatial ability), and (2) Matrix Reasoning (measures fluid reasoning skills where grasping of nonverbal concepts such as shapes, designs, visual-spatial patterns is essential).

There are two forms of savant syndrome. One is the acquired savant syndrome where an individual acquires unnatural or abnormal (prodigious) capabilities or skills following dementia, a head injury or severe blow to the head, or other disturbances. According to Treffert (2010), this syndrome is rarer with only 32 (or estimated 10%) had acquired savant syndrome with a registry of 319 known savants. Another form is the congenital savant syndrome, where, apart from about 50% of individuals with savant syndrome having autistic disorder, the other 50% are identified as having other types of developmental disabilities, intellectual disability, or other central nervous system injury (Treffert, 2009).

With the above two definitions of autistic savant from Edelson (1995) and Treffert (2000), the current definition of savant syndrome has contrasted exceptional skills with impairments in adaptive behaviors rather than with global intellectual

impairment (Miller, 1988; Heaton & Wallace, 2004). However, the deficits in adaptive behavior are commonly reported in individuals with high-functioning autistic disorder and this definition validate the inclusion of such individuals within the savant category (Klin, 2000).

In summary, autistic savant can simply be defined as individuals who are diagnosed with autistic spectrum disorder manifesting extraordinary special abilities (usually in art, music, or mental calculation) and remarkable memory as depicted in Figure 1 below.
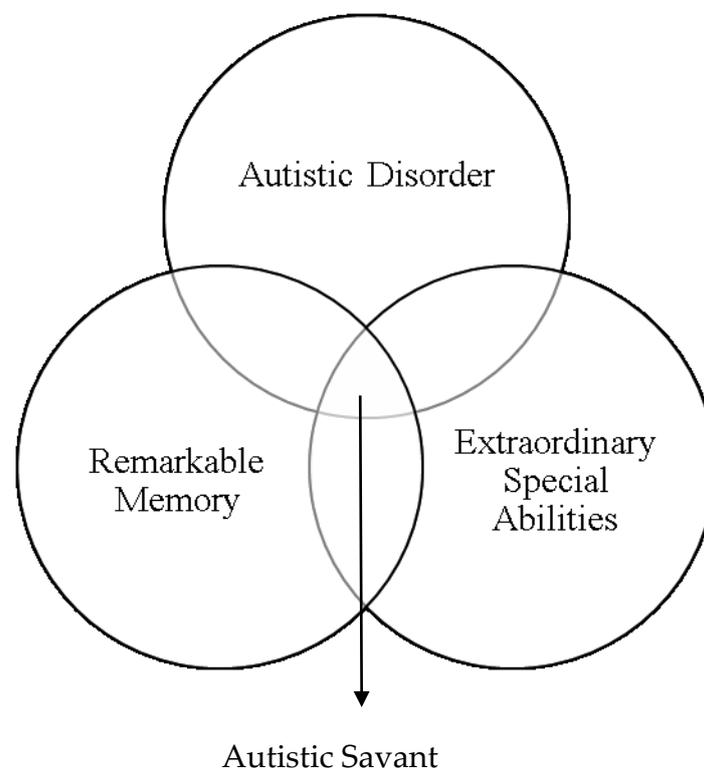
Figure 1: Manifestation of an Autistic Savant

6. ASD as a Continuum of Different Levels of Functioning

As mentioned earlier, being a spectrum disorder, autism is a behavioural syndrome of early childhood with a continuum in terms of the varying degree of severity that can be categorised under three levels of functioning:

(1) Low-Functioning Autism (LFA) includes individuals with moderate to severe autism that have an IQ below 70 and may have intellectual disability. They also manifest adaptive behavioural problems such as communication, socialization and daily living activities including self-care. Individuals with LFA are often observed to

be frustrated with poor or no communication and sensory overload leading to disruptive behaviours including self-injury. There are two sub-categories of LFA: those who are non-verbal and those who are verbal. Many of them do not live independently when they enter into adulthood.

(2) Medium-Functioning Autism (MFA) refers to individuals with IQ ranging between 70 to 85 and they may have some degree of intellectual disability. However, they are not severely impaired enough to be accepted as low-functioning nor intelligent enough to be considered high-functioning. As they become adults, they continue to depend on others to help them, though they manifest some level of independence in terms of their living that needs some form of support and their jobs require some form of structured or supported employment assistance. Like many of those with LFA, they do have problems in communicating verbally.

(3) High-Functioning Autism (HFA), which has been discussed in detail earlier, refer to those with low average to average intelligence and there are also those whose IQ may be way above the average range. They display usually normal verbal skills but their non-verbal skills are not as good compared to a neurotypical. Many of individuals with HFA are capable of independent living, gainfully employed, and some even get married with children. However, they are often seen as rude, weird, aloof or anti-social and as such continue to be plagued with social skills challenges.

7. Nonverbal and Verbal Low-Functioning Autism (NV-LFA and V-LFA)

LFA is often associated with impaired linguistic and verbal intellectual abilities. Such impairments have been traced to a pervasive impairment of declarative memory (Boucher, Mayes, & Bigham, 2008). Individuals with LFA have diverse profiles of language impairment that change with age (Rapin & Dunn, 2003) as well as range from mild to profound in terms of severity and thus, resulting in two subcategories of LFA: (1) nonverbal LFA (NV-LFA) with no language or negligible communicative language and verbal LFA (V-LFA) with some useful language.

Not all individuals with NV-LFA are profoundly intellectually impaired. This group of individuals "*have total, or near total, but selective loss of declarative memory, leaving procedural memory at least relatively intact*" (Boucher, Mayes, & Bigham, 2008, p.279). In other words, such individuals with intact non-declarative, procedural memory can still acquire basic-level categorical knowledge based on sensory-perceptual experience, and some daily living skills and routines through implicit learning. There are also uneven patterns of visuo-spatial abilities observed in their performance on formal intelligence tests (Kraijer, 2000). This group of NV-LFA individuals is what Chia

and Chua (2014) have described as severely lacking in mindfulness and mindsight. However, individuals with NV-LFA who are profoundly and pervasively intellectually impaired have total or near total loss of both declarative and procedural memory (see DeLong & Heinz, 1997). This latter group could be described as totally *mindless* and *mind-blind* contrasting to the former group of severely less mindful and lacking in mindsight (Chia & Chua, 2014).

Like those with NV-LFA, individuals with V-LFA also have declarative memory impairment especially on the acquisition of linguistic meaning, but their sparing of procedural memory leave the unconscious acquisition of phonology and grammar relatively intact. Hence, they are seen to possess some useful linguistic ability such as reproducing phonologically and grammatically correct language which gives the impression that their expressive language is superior to comprehension, masking the impaired productive expressive language. However, their lexical development remains most impoverished, and they display universal impairment of comprehension and meaning that is resulted "*from impaired access to memory for preverbal categorical knowledge of the world*" (Boucher, Mayes, & Bigham, 2008, p.275). In other words, children with V-LFA tend to make the kind of symbol-referent association (underlying denotation) in learning to label a specific referent they encounter than the normal symbol-reference association (underlying connotation) that non-autistic children do. This means that in the early word learning, such a child with V-LFA would assign concrete labels rather than rule-linked conceptual units (Fay & Schuller, 1980). The impaired declarative memory causes the child to have "*limited ability to integrate linguistic input with real-world knowledge*" (Lord & Paul, 1997, p.212). This, in turn, impairs comprehension can be traced back to the declarative memory deficit underlying the acquisition of linguistic meaning (Boucher, Mayes, & Bigham, 2008).

8. Identifying and Defining Autistic Crypto-Savantism in LFA

Earlier in this paper, the authors have cited the definition of autistic savantism from Treffert (2014) as "*a rare but spectacular condition in which persons with developmental disabilities, including but not limited to autism, or other central nervous system (CNS) disorders or disease have some spectacular 'islands of genius' that stand in jarring juxtaposition to overall limitation*" (p.564). According to Treffert (2014), such spectacular talents (e.g., drawing, piano playing, calendar calculating) are often single skills, but multiple skills can also happen too, but they are always associated with massive procedural memory (but with dysfunctional declarative memory) – "*very narrow but exceedingly deep within the confines of the special skill*" (p.564). However, Goldberg (1987) surmised that children

with hyperlexia or other savant syndromes have dysfunctional procedural memory, though their declarative memory is relatively intact. In other words, different impairments in either declarative memory (NV-LFA) or procedural memory or both (especially for those with NV-LFA who are profoundly and pervasively intellectually impaired) can result in different subtypes of autistic savantism.

Unlike the autistic savantism, there is another hidden category of autistic savants known as autistic crypto-savantism defined by Rimland (1990) as "*autistic individuals who, because of inability to communicate, or unwillingness to communicate, has savant skills which are hidden, or secret, and unknown to those around them, including their parents and teachers*" (p.3). The *inability to communicate* has to be qualified by the fact that such an individual with ASD must be assessed by a speech therapist to have language impairment in order to be diagnosed for ASD with Language Impairment (ASD-L) (Raiford, Drozdick, & Zhang, 2015). In other words, an autistic crypto-savant displays declarative memory impairment, which will affect language acquisition in all modalities. However, the authors of this paper believe there could also be those autistic crypto-savants with V-LFA who may have speech but their language comprehension is invariably impaired cross all modalities.

Impairment in declarative memory, which includes episodic memory and semantic memory, will also adversely affect verbal intelligence. According to Lim and Chia (2017), declarative memory impairment can be confirmed by poor performance in the subtests of the Wechsler intelligence scales in the Verbal group, namely, Comprehension, Information, Vocabulary, Arithmetic and Similarities, all are heavily dependent on linguistic knowledge per se and on declarative memory. Subtests in the Performance group are least likely affected by declarative memory impairment. Digit Span is relatively spared since it measures immediate memory with little dependence on either language or long-term declarative memory. Poor performance is also noted in Picture Arrangement and Digit Symbol/Coding (in Wechsler Adult Intelligence Scale) as they are partially dependent on language mediation and on declarative memory.

As such, based on Rimland's definition of autistic crypto-savant, he/she is also an individual with NV-LFA or V-LFA. However, not all with NV-LFA are intellectually impaired (Boucher, Mayes, & Bigham, 2008), and for such an individual to have *savant skills which are hidden, or secret, and unknown*, he/she has some form of intact procedural memory that has allowed him/her to strive in the hidden talents with a relatively intact nonverbal intelligence (best confirmed by formal nonverbal intelligence tests). As a result, Lim and Chia (2017) have fine-tuned the definition for autistic crypto-savant as "*a low-functioning autistic individual with poor adaptive functioning ability, especially with*

little or no ability to communicate, but a non-impaired non-verbal intelligence quotient (NVIQ), possesses certain savant skills that are hidden from or unknown to those around" (p.5).

In summary, the authors present the subcategories of autistic crypto-savantism in Figure 2 below.
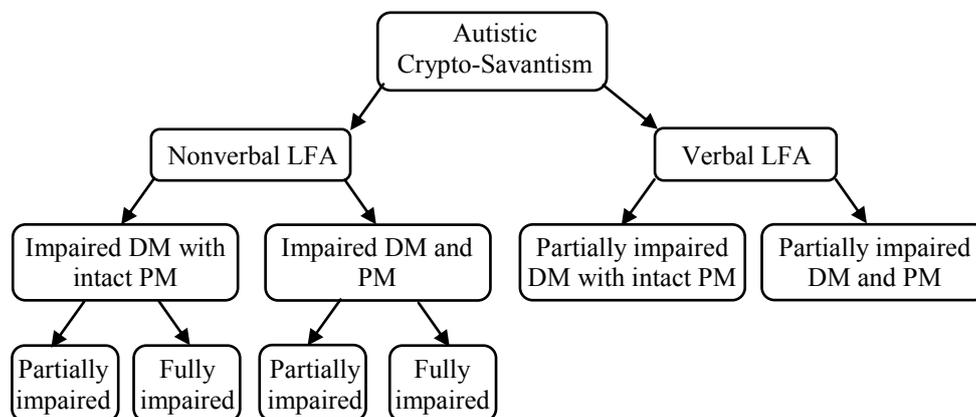
*DM: Declarative Memory; PM: Procedural Memory

Figure 2: Subcategories of Autistic Crypto-Savantism

Acknowledgement

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