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Understanding Giftedness in a Cognitive Mechanism: A Candidate for a Universally Agreed Definition of Giftedness

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This article provides a new definition of giftedness drawn from a cognitive mechanism. The mechanism shows how cognitive components are functionally related to each other and cooperatively "work" together, producing the various cognitive phenomena in the social world. The author argues that for a universally agreed definition, giftedness has to be understood in the mechanism, the origin of all the cognitive phenomena in cultural or social contexts. According to the definition drawn form the cognitive mechanism, giftedness is the ability to form a simple and fundamental domains-integrated knowledge of the "whole" world. A new method for identifying gifted students is subsequently suggested.

Key Words: Giftedness, Universally agreed definition of giftedness, Identification of giftedness

I. Introduction

Numerous definitions of giftedness exist. It is no wonder considering that there are multiple definitions of intelligence, talent (or expertise), and creativity, which constitute giftedness (Cramond, 2004; Kalbfleisch, 2008).

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As Cramond noted, the existence of multiple definitions of the constructs suggests that we are getting to know more and more of them, but researchers in the field have persistently pursued a universally agreed definition of giftedness. The dream may come true only when intelligence, talent, and creativity are defined in a universally agreed manner.

Some researchers argue that it is unrealistic to expect such agreement because the definitions have undergone the cultural and temporal relativity (Cramond, 2004); a variety of cultural and temporal settings force us to define endless definitions of giftedness (e.g., Gardner's added intelligences). As long as we define giftedness through performance (e.g., problem solving, reading, learning) or products (e.g., new entities or knowledge) in social or cultural contexts, we will never reach the universally agreed definition of giftedness.

For the agreed definition of giftedness, what if we define giftedness in the cognitive mechanism in the brain, which is general and constant to all individuals in any cultural and temporal settings. In other words, for the agreement, we need to define giftedness in the cognitive mechanism from which all the diverse cognitive phenomena in social or cultural environments are originated. The mechanism should show how the cognitive components in the mechanism are related to each other in function and cooperatively "work" together, producing various outcomes in cultural and temporal contexts. Through their functional interrelationships we may be able to figure out what intelligence, talent, and creativity are respectively in an agreed manner and even where they come from, and why and how they come into existence. The purpose of this article is to understand giftedness in a cognitive mechanism (Song, 2009; Song & Porath, 2005) and draw a new definition of giftedness from it in a universally agreed manner.

II. Review of an Integrated Model of Human Abilities

An integrated model of human abilities (Song, 2009; Song & Porath, 2005) was conceptualized based on interrelationships in function between abilities proposed by the major theories or models of intelligence - Three-Stratum Theory (Carroll, 1993), the united model of the mind (Case, Demetriou, Platsidou, & Kazi, 2001), the developmental theory (Case, 1992), Triarchic Theory (Sternberg, 1988), Multiple Intelligence Theory (Gardner, 1983). Because of their weak explanatory power of cognitive characteristics of gifted students and disagreement on general and domain-specific cognitive abilities, these models were 'rebuilt' in a unique way.

The integrated model is different from the major models or theories that informed it in some important aspects. Unlike the models or theories, the integrated model provides a cognitive mechanism explaining how cognitive components - abilities, attention, memory, space, entities or stimuli - are functionally interrelated to each other and "work" together, producing various cognitive phenomena.

Based on the interfunctionalities, the integrated model specifies the nature of intelligence in terms of ability or function. The model also explains which abilities are general and which abilities are domain-specific; how general intelligence (g) are related to other general abilities and domain-specific intelligences or abilities; how domain-specific intelligences or abilities are related to each other; how intelligence is related to attention and memory; how knowledge is formed domain-specifically; and what determines "domains" in terms of content and representation. The major models or theories do not provide the information.

No provision of the functional interrelationships (interfunctionalities) by the major models or theories has been the most critical barrier for researchers to understand giftedness in an agreed manner. Definitions of key concepts in the cognitive field such as intelligence, knowledge, creativity, talent, and learning disabilities may result from this model in an agreed manner. As a result, characteristics of gifted students with/without learning disabilities were explained better by the integrated model than the models or theories that inform it (Song, 2009).

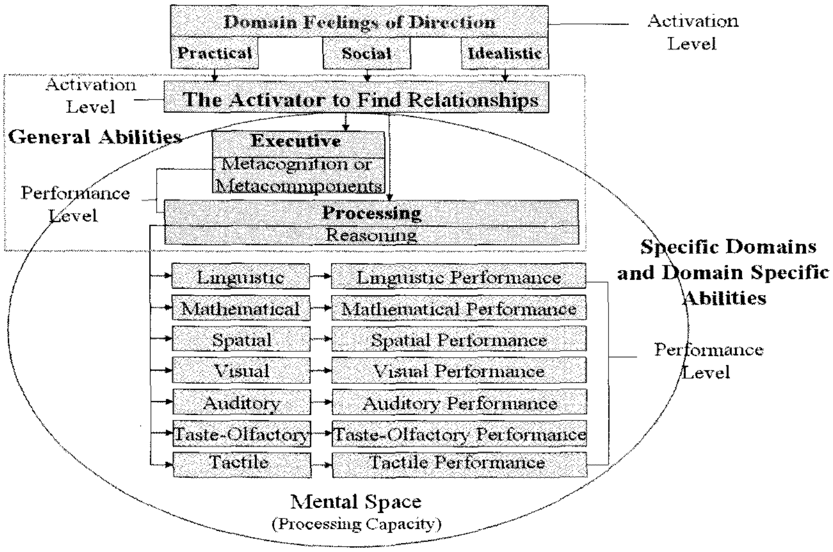
In this paper, the model is reviewed with regard to part relevant to giftedness.

1. Knowledge and Abilities

According to the model, humans are cognitive beings who are naturally curious about knowledge (character) and form it (ability). They find relationships between domain entities or stimuli in space (i.e., the world space and the mental space) and connect them through the found relationships. The connected stimuli are knowledge; knowledge consists of two components, relationships and stimuli. The character and ability of human beings were identified in the analysis of characteristics (Clark, 2002; Silverman, Chitwood, & Waters, 1986; Tuttle, 1983) and abilities (Carroll, 1993; Case, 1992; Case et al., 2001; Gardner, 1983; Sternberg, 1988) for common characteristics and abilities of gifted students (Song, 2004).

The ability to find relationships between domain entities or stimuli and form knowledge is defined as general intelligence (g). While finding relationships between entities or stimuli, an individual plans and controls his/her thinking processes (executive ability, i.e., metacognition, or metacomponents) (Demetriou, 2002; Sternberg, 1988) on one hand, and processes information (processing ability) (Sternberg, 1988) on the other. Executive and processing abilities are instrumental to g; an individual finds relationships through those functions. The three abilities that are involved in knowledge formation, g, executive, and processing, are defined as general abilities [Figure 1].

The interrelationships between the general abilities were found in the analysis of the common abilities suggested by the major models (Carroll, 1993; Case, 1992; Case et al., 2001; Sternberg, 1988) for functional inter-relationships (Song, 2004). According to the analysis, the ultimate purpose of the cognitive processes tapped by reasoning tests (Sternberg) and the executive operations in each developmental substage of a central conceptual structure (Case) was to find relationships between entities or stimuli with the help of metacognition or metacomponents (Case et al.; Sternberg) and processing ability (Sternberg).



Note. This is a two-dimensional representation of a multi-dimensional model.

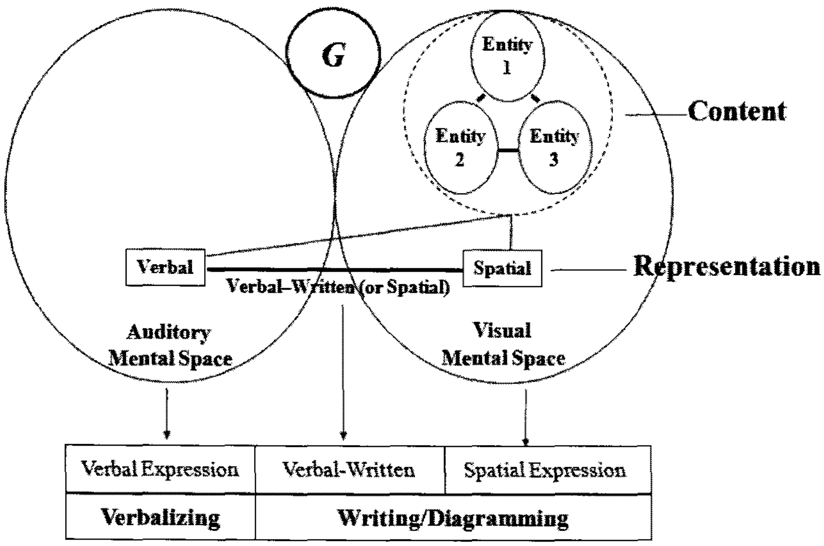
[Figure 1] The Integrated Model of Human Abilities (Song & Porath, 2005, p. 242)

When an individual is stimulated by internal or external demands ("activation level"), he or she may activate the instrumental cognitive functions - executive and processing functions ("performance level") - to find relationships. The individual who activates the instrumental functions is labeled as the activator (Song, 2004). The term "the activator" is used for ease of presentation; it is not meant to imply an entity separate from the individual (Song). Ability at the general activation level is labeled g; and the other general abilities as those at the general performance level [Figure 1].

According to the mechanism, the general abilities appear as domain-specific abilities when they are engaged with domain stimuli; g (general intelligence) appears to be domain-specific when it is engaged with domain stimuli [i.e., multiple intelligences as defined by Gardner (1983)]. The term used in the cognitive mechanism of the model, "domain-specific abilities or intelligences," refer to the general abilities or g in domains; domain-specific abilities, as defined in this study, are not considered support for Gardner's concept of multiple intelligences. For example, when g is engaged with linguistic stimuli (g in linguistic domain), it appears as linguistic intelligence, and if g is engaged with mathematical stimuli (g in mathematical domain), it appears as mathematical intelligence (Gardner's term). Accordingly, the kind of stimuli coming through the sensory organs, which are connected and formed to become domain knowledge, determines domains; an individual 'must' have stimuli to process and connect.

2. Domains

Unlike definitions based on products or performance in social contexts (Gardner, 1983; Matthews, 1993), domains in the integrated model are defined in the processing context of the cognitive mechanism and specified in terms of content and representation. Content refers to entities or knowledge (entities and relationships), whereas representation refers to the form (i.e., human language) in which content is represented (i.e., symbolization) (Alexander, 1967; Gardner). Content can be represented by verbal (speaking), verbal-written (writing), or spatial-written (diagramming or ideographical) language [Figure 2]. For example, when we say or write "car," the entity of a car is content and the verbal or verbal written word is its representation. When we represent a mountain by a triangle, the mountain is content and the triangle is its representation. Knowledge is also represented by language (e.g., novel, math, science).



[Figure 2] Representation of Knowledge

The integrated model suggests three content domains: practical, social, and idealistic. The domains were identified from abilities or intelligences suggested by major models or theories of intelligence (Carroll, 1993; Case, 1992; Case et al., 2001; Gardner, 1983: Sternberg, 1988) - practical (Sternberg), social (Case; Gardner; Sternberg), and idealistic (Song, 2004; Song & Porath, 2005) abilities or intelligences that are related to practical, social, or idealistic thought content. Practical intelligence is related to daily material entities or adaptation to new cultures (i.e., practical ideas); social intelligence to human minds (i.e., mental entities) or knowledge of human mental states (i.e., social ideas); and idealistic abilities to rule systems (i.e., abstract entities) or sense of justice or fairness (i.e., idealistic ideas). Social intelligence includes emotional thought (Case, 1985) (i.e., social and emotional) and is equivalent to Gardner's personal intelligence (i.e., inter- and intra-personal) (Song).

This model suggests linguistic, mathematical, spatial, auditory, visual, taste, olfactory, and tactile domains as representation domains. Linguistic, mathematical, spatial, auditory, and visual representation domains were suggested by major models or theories of intelligence (Carroll, 1993; Case, 1985; Case et al., 2001; Gardner, 1983: Sternberg, 1988). Taste, olfactory, and tactile stimuli were added by Song (2004).

In this model, representation domains are determined by the kind of stimuli coming into the mental space through the sensory organs [i.e., auditory (ear), visual (eye), taste (mouth), olfactory (nose), and tactile (skin) domain stimuli]. The individual sensory stimuli are basic and independent; they are connected for domain performance or knowledge. An individual forms domain knowledge (or does performance) with the stimuli through processing in an independent or integrated manner. In processing contexts, the respective domain stimuli are processed and connected and formed as independent domain performance or knowledge. For example, in some visual arts, stimuli may only be visually processed and connected. Where representation is integrated, multiple independent domain stimuli are processed and connected and formed as integrated domain performance or knowledge. In reading or math, for instance, auditory and visual domain stimuli are connected because language and number are phonological or verbal (i.e., auditory) and written (i.e., visual) representation stimuli. Therefore, viewed from the social product-based definitions, language- and math-related domains seem independent, but they are integrated in processing contexts.

As defined in this study, domain reflects the cognitive mechanism in which multiple cognitive components work cooperatively and yield products or performances in social contexts; cognitive processing precedes appearance of domain products or performances in social contexts. The definition may be more useful in understanding abilities or disabilities of gifted students than a social product-based definition because they can be understood more scientifically in the fundamental neurological and processing contexts, in which domains or intelligences (Gardner's term) defined in social contexts can be analyzed into smaller independent domains or intelligences. Individuals may show practical-, idealistic-, and/or social-relevant abilities or characteristics when they engage with the content of those domains, and auditory-, visual-, taste-, olfactory-, and/or tactile-relevant abilities or characteristics when they engage with those domain representations in an independent or integrated manner.

Meanwhile, when considered according to the definition of domain in this study, academic "subject areas" -- coherently organized bodies of knowledge (Marini & Case, 1989) -- may be interpreted as integrated domains in terms of representation and content, even though the subjects may differ only in the ratio of the independent domain contributions (Song, 2009). In representation, for example, auditory domain ability is stressed more in some subjects, whereas visual domain ability in others; and taste, olfactory, or tactile domain ability in still others.

3. Memory and Attention

According to the model, memory and attention are fundamental components for formation of knowledge along with abilities. In the mechanism of the model, attention is directed or attracted to entities or stimuli in space. And then, individuals, who are curious about relationships between the entities or stimuli, find the relationships and form knowledge in memory. The findings that memory and attention affects cognitive activities support this (Cherkes-Julkowski, Sharp, & Stolzenberg, 1997). This is also supported by the finding that attention works in concert with executive functioning (Barkley, 1996b) as well as working memory (Cherkes-Julkowski et al., 1997) and, thus, problems with attention can subsequently result in widespread difficulties (Zera & Lucian, 2001).

The mental space is the processing capacity available for processing and reasoning (Case, 1992). Short-term memory is the workplace for processing (mental space in this study) (Case; Halford, 1982; Halford, Maybery, O'Hare, & Grant, 1994). The mental space grows with age, and memory level is related to the size of mental space (Case, 1985); the larger the mental space, the stronger memory. The existence of domain memory and processing suggests that there are domain mental spaces (e.g., auditory and visual). Memory is domain-specific and independent: auditory memory vs. visual memory (Gardner, 1983; Winner, 1996). There is the phonological loop that is specialized for the retention of verbal information (i.e., phonological store) and a rehearsal process that maintains representations in the store (i.e., working memory) (Gathercole, 1998). The visual-spatial sketchpad is specialized for the processing and storage of visual material (Baddeley & Logie, 1999).

III. Results: A New Definition of Giftedness

The integrated model defines intelligence as the ability to find relationships between domain entities or stimuli and form knowledge of the world (g). Accordingly, giftedness, which is referred to the highest level of g, is defined as the ability to find the relationships between the whole entities in the world and form knowledge of the whole world. Given that intelligence is related to knowledge of the world, giftedness, which is the highest level of intelligence, must contribute to the knowledge of the whole world. Gifted individuals may be intrinsically motivated to infer the relationships connecting the whole entities in the world truthfully (i.e., inferential discovery) or creatively (inferential creativity) and form the knowledge of the whole world. Due to their high g, gifted individuals infer new relationships or are highly curious about new relationships (Song, 2004, 2009; Song & Porath, 2005). They may infer the most simple and fundamental relationships and entities, which let them know the world as a whole. It may not be possible to know the whole world by finding all the relationships between the whole entities of the world as they are; that is, individuals may not know the world as a whole through the complex and diverse aspects of the world. In short, they may be those who form simple and fundamental theories of the whole world. This may be supported by the cognitive direction to the "whole" and "simple and fundamental," which is found in the world great figures:

> At the height of Newton's power there was in him a compelling desire to find order and design in what appeared to be chaos, to distill from a vast inchoate mass of materials a few basic principles that would embrace the *whole* and define the *relationships* of its component parts··· In whatever direction he turned, he was searching for a *unifying structure*. (Gardner, 1983, p. 151)
>
> I (Einstein) soon learned to scent out that which was able to lead to *fundamentals* and to turn aside from everything else, from the multitude of things that clutter up the mind and divert it from the essential···" (Gardner, p. 148) "In Einstein's case, the very belief that there will be a few *simple laws*, that they will unify diverse phenomena, and that there will be no element of chance ··· Einstein is said to have remarked, "God wouldn't have passed up the opportunity to make Nature this simple." (Gardner, p. 150)

Giftedness may show their different levels (e.g., moderately, exceptionally, and extremely) (Lovecky, 1994; Winner, 1994). According to the definition that giftedness is related to knowledge of the whole world, the more gifted, the more curious he or she is about relationships connecting more entities in the world and form more knowledge of the whole world. Thus, individuals in the highest level of giftedness may be those who are most curious about the simple and fundamental relationships connecting the "whole" simple and fundamental entities including mental entity as well as physical entities of the phenomenal world and form knowledge of the "whole" world. Their giftedness may account for scientific theories (e.g., Big Bang Theory), or religious theories or beliefs (e.g., Buddhist scriptures or the Bible).

The highest level of giftedness is discriminated as 'original giftedness' from 'phenomenal giftedness' in that the former is related to the simple and fundamental original entities of the phenomenal world (e.g., one spot or God for the natural world, spirit or the mental entity in the model for the social world), and the simple and fundamental relationships between the original entities and those in the phenomenal world, whereas the latter is to the simple and fundamental relationships between the simple and fundamental phenomenal entities (e.g., $e=mc^2$). Thus, the original giftedness may be qualitatively different from phenomenal giftedness.

IV. Conclusions and Discussion

This paper was intended to understand giftedness in a cognitive mechanism in which cognitive components "work" together, producing cognitive phenomena (e.g., intelligence, giftedness). The paper provides a new perspective on giftedness in some points. Firstly, giftedness is related to the ability to deal with relationships between entities or stimuli (i.e., knowledge), not the ability to deal with representation of knowledge. In this paper, the ability to deal with representational stimuli in reading, writing, math, music, or art, for example, is differentiated from g, which may be termed as "expertise (or skill)," high level of which is defined as "talent," compared to giftedness. Next, this paper suggests that giftedness is related to knowledge of the real world, not abstract worlds (e.g., novel, math, art). It is also related to the knowledge of the whole world; gifted individuals may be intrinsically interested in the knowledge of the whole world, not in specific domains. Finally, this paper suggests qualitatively different two levels of giftedness: phenomenal giftedness and original giftedness.

The new perspective of giftedness challenges the present definitions of giftedness and requires a dramatic shift in its paradigm. The traditional concept of giftedness supported by g theories, which is highly dependent upon IQ tests with linguistic and mathematical foci, may be biased. IQ tests, which allegedly measure level(s) of intelligence, may not measure level(s) of pure intelligence, g, because they may measure level(s) of expertise (or skill) at the same time. According to the model, knowledge is represented by language in the mental space. That is, linguistic work is possible in the mental spaces because individuals process linguistic stimuli and finding relationships between them in the mental space, and high linguistic work (e.g., reading, writing, and math) requires strong domain memory (or big mental space) as well as g (Song, 2009). As a result, some gifted students with poor specific domain memory (e.g., gifted student with learning disabilities) may show poorer specific domain IQ scores or specific academic achievement than ordinary students with strong memory (Song). Conversely, depending on test items or learning content, students with a high level of expertise (i.e., talent) but an average level of g can achieve high scores in IQ tests or school learning and be labeled as gifted.

More recently, in the perspective of multiple intelligences which allow for multiple domain giftedness, students are identified as "gifted" in a multifaceted manner. Individuals who show high abilities in specific domains, they are labeled as "gifted" and supported to concentrate on working in their gifted domains. From this viewpoint, endless new giftedness is expected to be labeled in constantly changing social and cultural contexts. Gifted individuals in specific domains go nowhere in multiple directions infinitely.

This paper suggests that giftedness is directed toward the "whole" (i.e., integration among domains, not divergence or separation) and simplicity and fundamentals, not complexity and diversity. Attention should be paid to identifying gifted students who show high interest in the relationships between the whole entities in the world, which is simple and fundamental, or show high ability to form inferential theories of the whole world. Instead of using IQ tests, learning ability or achievement, or other specific domain abilities, gifted students should be identified by the ability to infer relationships between the whole entities or inferential knowledge of the whole world formed by students themselves. Meanwhile, considering that the relationships may not be inferred in a short period of time, gifted students in early or school age can be identified by their strong curiosity or beliefs about the relationships connecting the whole entities in the world.

Although the development of identification methods according to the new definition of giftedness may take time and effort because it was newly defined, a sample of recommendations is suggested. For identifying giftedness, students are asked to list their questions they have innately and persistently had and tried to infer the answer by themselves with strong commitment, or to describe their theories of the world they have formed by themselves through inference at the request of his intrinsic curiosity. And then, the questions or theories are analyzed for relationships between entities. Next, the questioned or stated relationships are evaluated whether they are directed to the phenomenal world or the original entities of the phenomenal world. Finally, the relationships and entities are checked to see if they are directed to the knowledge of the whole world and how simple and fundamental they are.

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= 국문초록 =

인지메카니즘 내에서의 영재성의 이해: 보편적이고 통일된 새로운 영재에 대한 정의

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이 논문은 인지메카니즘으로부터 도출된 새로운 영재에 대한 정의를 제시하고 있다. 그 메커니즘은 인지구성요소들이 기능적으로 어떻게 서로 관련되어 있고 어떻게 서로 협동적으로 작용하여 사회적 환경에 다양한 인지현상들을 창조해내는가를 설명하고 있다. 저자는 보편적이고 통일된 정의를 위해서는 영재성이 사회적 문화적 상황에 존재하는 모든 인지현상들의 원인적 존재인 인간의 인지메카니즘에서 이해되어야 한다고 주장한다. 인지메카니즘에서 도출된 영재의 개념에 의하면 영재는 전체 세계에 대한 단순하고 근본적인 분야 통합적 지식을 형성하는 능력이다. 새로 도출된 영재의 개념에 따른 영재성 판별 방법도 제시했다.

주제어: 영재성, 보편적이고 통일된 영재의 정의, 영재성 판별

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