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Disability as a Catalyst for Giftedness: Exploring Crossmodal Plasticity and a Teleological Framework for Understanding Exceptional Cognitive Abilities

This paper challenges the traditional dichotomy between disability and giftedness by exploring the potential for sensory loss to act as a catalyst for exceptional abilities in other domains. Drawing on the concept of crossmodal plasticity – the brain's remarkable ability to reorganize and compensate for sensory deprivation – the paper argues that individuals who experience sensory loss, particularly at an early age, may develop heightened abilities in their remaining senses, surpassing typical levels of functioning. This argument stems from the understanding that when one sensory pathway is compromised, the brain reallocates neural resources to strengthen other sensory modalities. This compensatory mechanism, often observed in individuals with blindness or deafness, can lead to enhanced perceptual abilities in areas such as auditory processing, tactile sensitivity, or spatial navigation. The paper proposes a teleological framework for understanding giftedness in this context, suggesting that exceptional abilities arising from sensory loss serve a compensatory function, enabling individuals to navigate the world effectively despite their impairments. This perspective challenges the notion of giftedness as solely an innate trait, highlighting the significant role of environmental factors and neural adaptation in shaping human potential. By presenting evidence from existing research on crossmodal plasticity and anecdotal examples of individuals with sensory impairments who have developed extraordinary abilities, the paper encourages a more nuanced and inclusive understanding of human potential. Ultimately, the paper calls for further research to fully explore the implications of crossmodal plasticity for understanding the complex relationship between disability and giftedness, advocating for a strengths-based approach that recognizes and nurtures the unique talents of all individuals, regardless of perceived limitations.

Keywords: *inclusive understanding of human potential, cognitive abilities, disability, giftedness, crossmodal plasticity, compensatory mechanism, teleological framework, environmental factors.*

Research Problem

The research problem this paper tackles is the limited and often dichotomous understanding of the relationship between disability and giftedness.

The paper challenges the traditional view that sees these two concepts as separate and distinct, arguing instead for a more nuanced perspective that recognizes their potential interconnectedness.

Specifically, the paper explores the following:

- *How crossmodal plasticity challenges the disability/giftedness dichotomy:* By highlighting the brain's ability to compensate for sensory loss by enhancing other senses, the paper questions the assumption that disability inherently limits potential.
- *The possibility of disability acting as a catalyst for giftedness:* The paper explores whether the experience of disability, particularly sensory loss, can actually drive the development of exceptional abilities in other areas.
- *The implications of a teleological framework for understanding giftedness:* By suggesting that giftedness might serve a compensatory function, the paper challenges traditional views of giftedness as solely innate and independent of environmental factors.

In essence, the paper aims to broaden our understanding of both disability and giftedness by exploring their potential interplay and challenging us to reconsider the very definitions of these concepts.

Research Purpose

The research purpose of this paper is to explore and illuminate the potential for disability, particularly sensory loss, to act as a catalyst for the development of giftedness through the mechanism of crossmodal plasticity.

The paper aims to achieve this by:

1. *Challenging the traditional dichotomy between disability and giftedness:* By presenting evidence of crossmodal plasticity and its role in enhancing other senses following sensory loss, the paper seeks to dismantle the perception of disability as solely a limitation and giftedness as solely an innate trait.
2. *Examining the order and nature of events in crossmodal plasticity:* By analyzing how sensory loss often precedes the development of exceptional abilities in other areas, the paper aims to establish a potential causal link between disability and giftedness, suggesting that the former might be a necessary precursor to the latter in certain contexts.
3. *Proposing a teleological framework for understanding giftedness:* By suggesting that giftedness, particularly as manifested through crossmodal plasticity, serves a compensatory function, the paper aims to offer a new perspective on the nature and purpose of exceptional abilities.

Ultimately, the paper seeks to contribute to a more nuanced and inclusive understanding of human potential, recognizing the complex interplay between ability and disability, and challenging us to reconsider our definitions of both.

Research Significance

The significance of this research lies in its potential to transform our understanding of the relationship between disability and giftedness, with far-reaching implications for both theory and practice [Subotnik, et al. 2011; Wai, & Lovett 2021; Foley Nicpon, et al. 2010; Ellis-Schwabe, & Conroy 1983]. By presenting a framework that views disability, particularly sensory loss, as a catalyst for the development of exceptional abilities, the paper challenges the entrenched dichotomy between these two concepts [Foley Nicpon, et al. 2010].

This alternative perspective not only questions the assumption that disability inherently limits potential, but also suggests that the experience of disability may, in fact, be a necessary precursor to the emergence of giftedness in certain domains.

This paper holds significance on several levels:

Theoretically:

- *Challenges traditional paradigms:* It disrupts the binary understanding of disability and giftedness, prompting a paradigm shift towards recognizing their potential interdependence. This challenges existing theories of human potential and encourages a more holistic view of ability.
- *Introduces a new framework:* By proposing a teleological framework for understanding giftedness – that it can arise as a compensatory mechanism – the paper offers a fresh perspective on the development and purpose of exceptional abilities.

Practically:

- *Promotes inclusivity:* By highlighting the potential within disability, the paper encourages a more inclusive understanding of human diversity and challenges societal biases against individuals with disabilities.
- *Impacts educational and therapeutic approaches:* Understanding the link between sensory loss and heightened abilities can inform educational strategies for students with sensory impairments, focusing on their strengths and leveraging crossmodal plasticity for learning. It can also influence therapeutic interventions, emphasizing compensatory skill development.

Overall:

- *Advances knowledge:* The paper contributes to a deeper understanding of brain plasticity and its role in shaping human potential, opening new avenues for research in neuroscience, education, and disability studies.

- *Promotes social change:* By challenging deeply ingrained perceptions of disability and giftedness, the paper has the potential to foster greater empathy, understanding, and appreciation for the diverse spectrum of human abilities.

This paper's exploration of crossmodal plasticity and its implications for understanding the disability-giftedness nexus holds significant theoretical, practical, and social implications, making it a valuable contribution to multiple fields.

The paper begins by challenging the traditional dichotomy between disability and giftedness, which often portrays these concepts as mutually exclusive [Subotnik, et al. 2011; Wai, & Lovett 2021].

Research Question

The central research question this paper grapples with is:

Can disability, particularly the loss of a sensory modality, act as a catalyst for the development of giftedness in other domains through the mechanism of crossmodal plasticity?

This overarching question encompasses several sub-questions explored throughout the paper:

- How does crossmodal plasticity challenge the traditional dichotomy between disability and giftedness?
- Does the experience of disability, specifically sensory loss, precede and potentially necessitate the emergence of exceptional abilities in other areas?
- Does viewing giftedness through a teleological lens, as a compensatory mechanism for disability, offer a more comprehensive understanding of its nature and purpose?

By investigating these questions, the paper aims to unravel the complex relationship between disability and giftedness, ultimately challenging readers to reconsider their understanding of human potential.

Research Hypothesis

While the paper doesn't explicitly state a formal hypothesis, we can infer it from the central argument and research questions. The implied research hypothesis is:

Individuals who experience sensory loss at an early age will demonstrate a higher likelihood of developing exceptional abilities in other sensory modalities, specifically those that compensate for the impaired sense, compared to individuals without sensory loss.

This hypothesis suggests a directional relationship where disability, particularly sensory loss, acts as a catalyst for the development of specific giftedness through crossmodal plasticity.

The paper further implies that this relationship might be explained by the brain's adaptive capacity:

- *Compensatory Development:* The brain reallocates resources to enhance remaining senses in response to the loss of one, leading to heightened abilities in those areas.
- *Teleological Function:* Giftedness, in this context, serves a compensatory function, enabling individuals to navigate the world effectively despite their sensory impairment.

While the paper doesn't present quantitative data to test this hypothesis directly, it builds a compelling argument based on existing evidence of crossmodal plasticity and anecdotal examples of exceptional abilities in individuals with sensory impairments. The exploration of this hypothesis holds significant implications for our understanding of the relationship between disability and giftedness, challenging the prevailing view that they are mutually exclusive. Importantly, the paper acknowledges the need for further empirical research to substantiate the proposed relationship.

Background

The traditional educational landscape has often maintained a strict divide between students with disabilities and those identified as «gifted,» with little consideration for the potential overlap or interplay between these two populations [Foley Nicpon, et al. 2010]. However, a growing body of research suggests that the experience of disability, particularly sensory impairment, can serve as a catalyst for the development of exceptional cognitive abilities. This phenomenon, known as «twice-exceptionality» (2e individuals), challenges the simplistic dichotomy between disability and giftedness, revealing a more nuanced relationship between the two [Ellis-Schwabe, & Conroy 1983].

At the heart of this perspective is the remarkable neuroplasticity of the human brain, which allows it to adapt to sensory loss through a process called crossmodal plasticity [Foley Nicpon, et al. 2010]. When an individual loses the ability to perceive one sensory modality, such as vision or hearing, the brain can reorganize its functions, channeling resources to enhance the remaining senses. This heightened sensory perception can, in turn, unlock exceptional cognitive abilities in other domains, such as enhanced memory, spatial reasoning, or creative thinking.

Researchers have documented numerous cases where individuals with sensory impairments demonstrate extraordinary skills and talents that may be considered «gifted.» For example, studies have found that blind individu-

als often exhibit superior auditory perception, allowing them to develop exceptional musical abilities or enhanced navigation skills [Foley Nicpon, et al. 2010]. Similarly, the occipital cortex of early blind individuals has been shown to demonstrate increased responsiveness to non-visual stimuli, suggesting the brain's remarkable capacity to adapt and repurpose its resources. This neuroplastic process, known as crossmodal plasticity, highlights the dynamic and interconnected nature of the human brain, challenging the notion that disability and giftedness are mutually exclusive.

In the realm of gifted education, the concept of twice-exceptionality has garnered significant attention, focusing on individuals who exhibit both giftedness and a learning disability [van Viersen, et al. 2016]. This intersection of exceptionalities poses challenges in identification and support, as traditional assessments may overlook giftedness in students with disabilities and vice versa [Atmaca, & Baloğlu 2022].

The complexity of twice-exceptionality lies in the dynamic nature of both giftedness and disability, which can vary within individuals and across different contexts [Ronksley-Pavia 2015]. Understanding this dynamic interplay is crucial for educators and psychologists to provide appropriate interventions that cater to the unique needs of twice-exceptional learners. Research has highlighted the importance of recognizing the cognitive and psychosocial characteristics of gifted students with disabilities, as their giftedness may be obscured by average academic performance [Assouline, et al. 2010]. This discrepancy between potential and achievement underscores the necessity of comprehensive assessments that consider both strengths and weaknesses simultaneously [Maddocks 2018].

Failure to acknowledge the coexistence of giftedness and learning disabilities may result in missed opportunities to nurture the talents of these individuals [Ronksley-Pavia, et al. 2018]. Moreover, the stigma associated with disabilities and giftedness can perpetuate negative stereotypes and hinder the development of twice-exceptional children [Ronksley-Pavia, et al. 2018]. Identifying and supporting twice-exceptional students require a nuanced understanding of their unique needs and challenges [Townend, & Brown 2016].

These individuals often face a delicate balance between their exceptional abilities and areas of difficulty, necessitating tailored interventions that address both aspects of their profile [Szymanski, & Corn 1989].

Moreover, the association between giftedness and neurodevelopmental disorders further complicates the landscape of twice-exceptionality, emphasizing the need for specialized approaches to cater to the diverse needs of these individuals [Kontakou, et al. 2022]. Educators and psychologists play a pivotal role in facilitating the holistic development of twice- exceptional learners by providing personalized support that nurtures their strengths while addressing their challenges [Ronksley-Pavia 2020]. The assessment of

twice-exceptional students involves navigating the complexities of identifying giftedness in individuals with disabilities and vice versa [Mather, & Schneider 2023]. The masking effect, where giftedness conceals disabilities and vice versa, underscores the importance of using comprehensive evaluation tools that capture the full spectrum of students' abilities [Mather, & Schneider 2023]. By adopting a holistic approach to assessment that considers cognitive, academic, and psychosocial factors, educators can gain a more accurate understanding of the unique profiles of twice-exceptional learners [Maddocks 2018]. This comprehensive evaluation is essential for developing targeted interventions that optimize the potential of these individuals and support their holistic development [Henderson, & Jarvis 2016].

The literature on twice-exceptionality underscores the intricate interplay between giftedness and disabilities, emphasizing the need for tailored support that addresses the diverse needs of these individuals. By recognizing the dynamic nature of both exceptionalities and employing comprehensive assessment strategies, educators and psychologists can create inclusive learning environments that nurture the talents of twice-exceptional learners. Understanding the complexities of twice-exceptionality is essential for promoting the holistic development of these individuals and empowering them to thrive academically and socially.

The field of gifted education has increasingly acknowledged the phenomenon of twice-exceptionality, which challenges the oversimplified dichotomy between disability and giftedness (Lee & Ritchotte, 2017). Indeed, research has demonstrated that sensory impairments can unlock exceptional cognitive abilities through the brain's remarkable neuroplasticity [Chamberlin, et al. 2007; Hua, et al. 2014; Lee, & Ritchotte 2017; Foley Nicpon et al., 2010]. This cross-modal plasticity highlights the dynamic and interconnected nature of the human brain, expanding our conception of how disability and giftedness can coexist.

The assessment and support of twice-exceptional learners, however, remain complex and multifaceted. Identifying giftedness in students with disabilities, or vice versa, requires a comprehensive evaluation that considers cognitive, academic, and psychosocial factors [Foley Nicpon, et al. 2010]. Failure to acknowledge this coexistence can result in missed opportunities to nurture the talents of these individuals, who often face a delicate balance between their exceptional abilities and areas of difficulty.

Comprehensive assessment approaches, such as routines-based assessment and play-based assessment, can provide critical insights into the unique profiles of twice-exceptional students [Reis, et al. 2014; Chamberlin et al., 2007]. These practices allow educators to observe children in their natural environments, gathering valuable information about their strengths, needs, and family priorities. By blending recommended assessment techniques from

gifted education and special education, researchers have proposed a more holistic approach to identifying and supporting twice-exceptional learners, particularly in the crucial preschool years.

Overview

Gifted and talented individuals have long been a subject of fascination and study, with researchers seeking to understand the complex interplay of genetic, environmental, and developmental factors that contribute to the emergence of extraordinary abilities [Noel, & Edmunds 2006] (The development of giftedness and talent across the life span., 2009). Recent work has suggested that the experience of disability, far from being a hindrance, may in fact serve as a catalyst for the development of exceptional cognitive capacities [Noel, & Edmunds 2006; Gómez-León 2020]. One potential mechanism underlying this phenomenon is the phenomenon of crossmodal plasticity, wherein the brain's functional reorganization in response to sensory deprivation leads to enhanced performance in spared modalities [Subotnik, et al. 2011]. Additionally, the unique temporal processing abilities of some gifted individuals, particularly those with atypical developmental trajectories, may provide a framework for understanding the emergence of exceptional skills [Gómez-León 2020].

For instance, children with sensory disabilities, such as visual or auditory impairments, have been shown to exhibit heightened abilities in other domains, such as auditory or tactile perception, respectively [Gómez-León 2020]. This is thought to occur due to the brain's remarkable capacity for reorganization, allowing unimpaired sensory modalities to expand their cortical representation and processing resources to compensate for the loss of input in the affected domain [Ellis-Schwabe, & Conroy 1983; Subotnik, et al. 2011; Gómez-León 2020]. Similarly, individuals with dyslexia have been found to demonstrate enhanced visuospatial and creative abilities, potentially stemming from a distinct temporal processing profile that allows for the parallel processing of information and the integration of disparate elements into novel conceptual frameworks [Armstrong 2016; Gómez-León 2020].

The complex interplay between disability and giftedness has been the subject of extensive research, with studies suggesting that the experience of overcoming challenges can foster the development of unique cognitive strengths and abilities [Ellis-Schwabe, & Conroy 1983]. For example, children with Attention Deficit Hyperactivity Disorder (ADHD) have been shown to exhibit heightened creativity and divergent thinking, as their atypical neurological profiles may facilitate the rapid generation of novel ideas and the ability to make unexpected connections [Hua, et al. 2014].

Furthermore, the concept of «twice-exceptional» individuals, who are both gifted and have a disability, has gained increasing recognition in the field of special education [Hua, et al. 2014]. These individuals often possess a distinct set of cognitive and emotional characteristics that require specialized educational approaches to nurture their full potential [Hua, et al. 2014]. Inquiry-based instruction within a community of practice has been identified as a promising approach for developing the talents of gifted – ADHD college students, as it allows for the integration of their unique strengths and the mitigation of their perceived deficits [Hua, et al. 2014; Armstrong 2016].

Creativity, in particular, has been an area of interest in the study of the relationship between disability and giftedness. Gifted children, including those with various exceptionalities, have been found to exhibit heightened creative abilities, which may be rooted in the structural and functional configurations of their neural systems [Gómez-León 2020]. This neurological foundation, coupled with the right environmental conditions, can foster the optimal development of creative capacities.

The genetic expression of gifted children, when interacting with supportive environments, can give rise to the cognitive and emotional variables that underlie creative potential. Adequate understanding of these physiological, cognitive, and emotional factors is crucial for nurturing creativity during the formative early childhood years, as exposure to favorable or unfavorable environments can have profound intellectual, social, and emotional consequences.

Recent research has suggested that inquiry-based instruction within an authentic community of practice can play a vital role in fostering talent development for gifted-ADHD undergraduate students. These twice-exceptional individuals often possess a unique set of strengths and challenges, and specialized educational approaches that integrate their capabilities while mitigating perceived deficits are essential. The experience of overcoming challenges associated with disabilities can, in fact, serve as a catalyst for the emergence of exceptional cognitive abilities, as seen in individuals with sensory impairments, dyslexia, and ADHD.

One potential mechanism underlying this phenomenon is the process of crossmodal plasticity, wherein the brain's functional reorganization in response to sensory deprivation leads to enhanced performance in spared modalities [Ellis-Schwabe, & Conroy 1983; Gómez-León 2020]. For instance, children with visual or auditory impairments have demonstrated heightened abilities in other domains, such as auditory or tactile perception, as the brain allocates more resources to the unaffected senses. Similarly, the unique temporal processing abilities of individuals with dyslexia may contribute to their observed strengths in visuospatial and creative domains. Researchers have found that the experience of navigating and overcoming the challenges associ-

ated with various disabilities, rather than serving as a hindrance, can in fact catalyze the development of exceptional cognitive capacities.

This complex interplay between disability and giftedness has been the subject of extensive research, with studies suggesting that the process of adaptation and resilience in the face of adversity can foster the emergence of unique cognitive strengths and abilities. For example, the atypical neurological profiles of children with Attention Deficit Hyperactivity Disorder (ADHD) have been linked to heightened creativity and divergent thinking, as their cognitive processing styles may facilitate the rapid generation of novel ideas and the ability to make unexpected connections [Hua, et al. 2014].

Similarly, the concept of «twice-exceptional» individuals, who are both gifted and have a disability, has gained increasing recognition in the field of special education. These individuals often possess a distinct set of cognitive and emotional characteristics that require specialized educational approaches to nurture their full potential.

Time As a Framework

Time has several aspects that could be extremely enlightening that we will consider adopting. Those aspects or dimensions are Order, Onset, Duration, and Velocity. Order refers to arrangement of things relative to one another. Onset relates to how and when something begins. Duration concerns how long something occurs. Velocity refers to the rate at which time is perceived to travel.

Let us begin with the temporal aspect of order that characterizes the relation between gifts (g) and disabilities (d) as either one of "precedence" or "concurrence". In other words, one and only one of the following situations may be the case: g before d, g after d, or g and d come to be simultaneously.

Time is traditionally thought to be linear. Relations according to a linear view of time include before/after, earlier/later, and so forth. In relating g to d according to time, unless we allow for time to be circular, it would be impossible for both g and d to precede one another, as well as permit g and d to both come after one another. Nevertheless, a relation in which either both "g before d" and "d before g" OR "g after d" and "d after g" occur represents a simultaneous situation in which they come to exist at the same time referred to as concurrent. Conversely, nonconcurrent relations specify which of either comes before or after the other. We will consider an argument I present that supports precedence of gifts later in our discussion.

In addition to the aspect of sequence that imposes order, let us suppose another aspect of time was adopted for viewing the relation between gifts and disabilities referred to as causality. This perspective views the relation between gifts and disabilities as though one causes the other. What is most

intriguing about this frame is that the causal dimensional/relational perspective entails or "subsumes" that of order of the "temporal".

That is, to say, I know that whatever is a cause of an effect necessarily precedes it. However, one must beware not to succumb to logically fallacious conclusions.

One such fallacy is "post hoc, ergo, propter hoc", which says, "after this, therefore, because of this". The fallacy warns that order itself does not imply causality, which means that it is false to conclude that "whatever precedes an event is necessarily its cause". The view on the relation between gifts and disabilities being causal implies that at least one of following is correct: g causes d, d causes g, each one causes the other, or neither does. Under causality as a framework, the relation d causes g and g causes d will be presented with my argument through a hypothetical case in support of it as a relation.

Argument from time as a framework for gifts and disabilities

In adopting time to characterize the relationship that exists between gifts and disabilities, we are initially limiting ourselves to conceding inclusively either "precedence" or "concurrence". That is, to say, one exceptionality precedes the other or they both come to be simultaneously. We now argue from the perspective of precedence as a constraint and continue until an inconsistency is encountered. Along with Lovett's statement, let us also assume that disability can exist isolated. Why? Because there is or has been someone with confirmed disability without validated gifts, the existence of at least one such individual implies isolation is possible for disability.

A potential explanation for the inability to validate gifts is either (a) an individual only has a disability, (b) someone who has a disability with a coexisting gift may not be able to manifest their gift in the presence of the disability, or (c) measurement instruments are unable to pick it up because of the disability. Without the existence of a gift, the manifestation of a gift, or the sensitivity of a measurement instrument to pick up gifts that exist, the person may only effectively be considered disabled. This means not all of those with disability possess gifts, or if some do possess them, then obtaining evidence is not possible. Under our assumptions, if all the gifted have, can, or will qualify as having some form of disability (i.e., 2e individuals), but not all those with disability have, can, or will have gifts (i.e., just disability), then one can reasonably conclude that disability precedes gift development!

An Evolutionary Failsafe for Gifts and Disabilities

As to why disability would be established prior to gifts, we may never know for certain.

Nonetheless, with time as our grounding framework, we can use basic principles of logic to reason our way through an argument. The main requirement for the process is to avoid inconsistency. One approach that we will use is to begin reasoning assuming the opposite of what we wish to claim, viz., that disability precedes gifts. As long as we do not contradict what was stated in previous remarks, we have not violated consistency.

So, let us suppose a time in the past in which disability before giftedness was not the norm among humans. This supposition forces us to contemplate a possible scenario in which the natural selection of humans who experienced disability before gifts occurs. Natural selection may be defined as the differential survival and propagation of a certain subset(s) of living organisms occurring over generations because members of the subset(s) have particular phenotypic variation absent from the rest of the population [Darwin 1859]. Phenotype refers to observable characteristics that are a consequence of interactive effects between one's genetics and their environment [Darwin 1859]. So, the process of natural selection happens over a lengthy period of time at the end of which only generations of descendants from the original subset(s) of the population with the right phenotypic characteristics remain. Moreover, considering the remaining people whose phenotypes were naturally "selected" survived while those without it did not, it can be inferred that having certain characteristics unequivocally confers an evolutionary advantage.

Concerning natural selection, although use of phenotype brings to mind traits such as complexion, height, and fast or slow twitch muscle fiber predominance, things like the ability to taste bitter or having hyperacusis are considered phenotypes as well. Furthermore, we must include constructs such as intelligence, which paves the way for both disability as well as giftedness to qualify as phenotypic traits. The only requirement for the phenotype is that it be an observable characteristic that results from a combination of genotype and environment according to the definition provided. Nevertheless, my own interpretation and rewording of the definition would replace the restrictive-sounding "observable" that is used since some may incorrectly interpret it to be a limitation set for sensory perception by use of the eyes. Because there are additional faculties of sound, taste, touch, and smell, I would use "perceptible" to convey sensory modality irrelevance.

It is my understanding that although a genetic mutation occurs or it does not, the process of natural selection in favor of that mutation occurs over time because of the conferral of some form of evolutionary advantage in possessing

phenotypic consequences. Thus, even without knowing what that advantage is or how it came about at this point, the author suspects that a switch to disability preceding gifts likewise confers a phylontogenetic edge. The sequence of events involved in the evolutionary development of a species or taxonomic group of organisms is the definition of phylogeny [Gittleman 2025]. Additionally, ontogenesis refers to "the process of an individual organism growing organically; a purely biological unfolding of events involved in an organism changing gradually from a simple to a more complex level" [Vocabulary 2025]. Thus, by *phylontogenetic edge*, the author refers to *the sequence that aides in the biological unfolding of events responsible for the existence and growth of an organism from simple to more complex in the evolutionary development of a species by either facilitating, protecting, or otherwise providing a specific benefit*.

The key aspect of the benefit from my interpretation of the definition of portmanteau deserving emphasis is that of sequence. I think of evolution not as isolated events, but in terms of a sequence of events. For example, along the human evolutionary timeline, bipedalism – our ability to walk upright on two feet – occurred and has remained our method of locomotion. The evidence abounds not only for the existence of our having relied on four limbs to move as a method of locomotion but also for such method evolutionarily preceding bipedalism. Just look at infants as they grow and transition into various subsequent stages developmentally. So, given quadrupedalism as an event preceded bipedalism as an event in our evolutionary timeline, prior to the bipedalism event that occurred, either (1) no preference existed for either mode of human automobility and we just happened to be quadrupedal, or (2) at some point we used two hind limbs first then subsequently switched to all four limbs for locomotion. There is a problem with these alternatives, however.

Firstly, if alternative (2) were the case, then assuming evolution, going from bipedalism to quadrupedalism conferred an evolutionary advantage and our being bipedal now subsequent to quadrupedalism would mean we took a step backwards to before being bipedal. In the case of an absence of preference, there are a few indicators that would validate the claim. For one, no preference would entail finding evidence of both biped- and quadrupedal locomotion in humans not just as children, but in adulthood as well. Also, there would be a closer proportion in each category than presently exists. Furthermore, the existence of no preference would suggest that both quadru- and bipedal alternatives might have arisen as variations of being locomotive, which itself was an alternative to either not being designed for locomotion or able to move out of the water (only inside) or locomotion without the use of limbs to move outside of an aquatic environment.

I would argue in favor of not being designed or able to move outside of water but only inside aquatic environments with two or four limbs, as do the sea animals that swim.

Moreover, with the exception of seals, perhaps, since sea-swimming creatures with only two fins would appear to be at an anatomical disadvantage in attempting to surface and ambulate, it would be evolutionarily consistent to have quadrupedal species evolve from the ocean prior to bipedalism occurring. In support of my hypothesis is the discovery of the walking epaulette shark [Goto, et. al. 1999]. This shark has four limb fins, the anterior two of which are unusual in their placement allowing for it to surface and walk. Other than snakes who have mastered it, locomotion without limbs would seem to be disadvantageous. Regardless, it is not that bipedalism as an event occurred in isolation; it is that the sequence of events switched from the alternative order or developed anew and remained that matters. Likewise, I argue that the switch to disability preceding gifts is not simply an isolated event; it is a sequence shift.

Instead of being gifted as an event preceding having disabilities as an event, or no precedence whatsoever, switching to experiencing a disability as an event preceding having a gift as an event is a change in the sequence of events! Now that we understand and have adopted the sequence of events framework for discussing evolution, let us consider how the switch to disability preceding gifts might be considered a benefit. This resequencing may confer an evolutionary advantage by promoting resilience and adaptability [Rothschild, & Woods 2012; Reynolds 2012].

Literature Review on Crossmodal Plasticity and Disability as Preceding Gift

The concept of «disability as preceding gift» has been explored in various scholarly contexts, including disability studies and neuroscience research on crossmodal plasticity [DeGrazia 2015; DePauw 2000].

Crossmodal plasticity refers to the brain's ability to reorganize and adapt its functions when one sensory modality is impaired, allowing other senses to compensate and even enhance their capabilities [Dickinson, et al. 2000].

Crossmodal plasticity, a phenomenon where the brain adapts to sensory deprivation by repurposing areas of the brain for processing information from other senses, has been a subject of extensive research in neuroscience [Frasnelli, et al. 2011]. This process involves the rewiring of neural circuits to compensate for the loss of input from one sensory modality, leading to enhanced processing in remaining sensory modalities [Sàenz, et al. 2008]. Studies have proposed various mechanisms underlying crossmodal plasticity, including the growth of new axons, altered synaptic pruning during development, and unmasking of latent crossmodal connections in the mature brain [Sàenz, et al. 2008]. These mechanisms highlight the brain's remarkable ability to reorganize and adapt in response to sensory changes, demonstrating the dynamic nature of neural plasticity.

Research on individuals with sensory loss, such as blindness, has provided valuable insights into the functional reorganization of the brain in the absence of visual input [Collignon, et al. 2013]. Studies have shown that blind individuals exhibit crossmodal plasticity, where regions of the occipital cortex typically involved in visual processing are recruited for auditory and tactile functions [Collignon, et al. 2013]. This recruitment of visual areas for processing non-visual information underscores the brain's capacity for adaptive changes in response to sensory deprivation, highlighting the role of crossmodal plasticity in optimizing sensory processing in the absence of visual input.

Furthermore, investigations into the neuroplastic changes in blind individuals have revealed the centralization of brain functions beyond the traditional sensory cortices [Ortiz-Terán, et al. 2016]. This centralization involves the reorganization of multimodal integration regions to support adaptive sensorymotor and auditory functions in the absence of vision [Ortiz-Terán, et al. 2016]. Such findings emphasize the extensive reach of crossmodal plasticity in reshaping neural networks beyond modality-specific areas, highlighting the brain's ability to adapt and optimize sensory processing through reorganization.

Studies have also explored the role of multisensory integration in promoting neuroplastic changes in response to sensory experiences [Yu, et al. 2010]. Neurons have been shown to retain sensitivity to cross-modal experiences beyond the typical developmental period, indicating the ongoing potential for multisensory neuroplasticity throughout life [Yu, et al. 2010]. This sustained sensitivity to cross-modal inputs underscores the continuous adaptability of the brain in integrating information from different sensory modalities, contributing to enhanced perceptual capabilities and neural efficiency.

Moreover, research on sensory-driven neuroplasticity has highlighted the importance of sensory stimulation in influencing brain function and behavior, particularly in the context of occupational therapy interventions [Lane, & Schaaf 2010]. Sensory input has been identified as a key factor in shaping brain function and promoting adaptive changes in neural circuits, underscoring the therapeutic potential of sensory-based interventions in facilitating neuroplasticity [Lane, & Schaaf 2010]. These findings emphasize the critical role of sensory experiences in driving neuroplastic changes and optimizing brain function in various contexts, including rehabilitation and cognitive enhancement.

In conclusion, the literature on crossmodal plasticity provides compelling evidence of the brain's remarkable capacity for adaptation and reorganization in response to sensory changes. Studies investigating sensory deprivation, multisensory integration, and neuroplasticity have shed light on the mechanisms underlying crossmodal plasticity and its implications for brain function and behavior. By elucidating the dynamic nature of neural plasticity and the role of sensory experiences in shaping brain function, research in this field offers valuable insights into the potential for optimizing sensory processing

and promoting adaptive changes in neural circuits. The concept of "disability as preceding gift" emerges as an intriguing perspective that aligns with the principles of crossmodal plasticity, suggesting that the resequencing of events from "gift preceding disability" to "disability preceding gift" may confer evolutionary advantages by fostering resilience and adaptability [Voss, et al. 2017; Dresp-Langley 2022; Mateos-Aparicio, & Rodríguez-Moreno 2019; Markham, & Greenough 2004].

Crossmodal Plasticity and Disability as Evolutionary Advantage

The concept of crossmodal plasticity, where the brain adapts and reassigns functions from one sensory modality to another, is especially relevant in this context [DeGrazia 2015]. When an individual experiences disability, whether congenital or acquired, the brain demonstrates remarkable flexibility in compensating for the loss or impairment of one sensory pathway by enhancing the function of the remaining senses. This adaptive neuroplasticity not only improves the individual's ability to navigate their environment, but also appears to confer broader evolutionary advantages [Bonsteel 2012].

The author is reminded of people who lost their vision at an early age: by adolescence and even into adulthood, their remaining faculties had significantly improved. In particular, their hearing had become so highly refined and developed that it was considered to be far superior to that of the sighted. Such superior hearing ability apparently had allowed for these individuals to negotiate their new lives quite successfully. Despite not being as well off as they were with sight, because these people fared far better with enhanced senses than without for obvious reasons, it appears that the enhancements accommodate for the recognized deficits due to the loss of vision. While not entirely incorrect, I would argue that to say these individuals adapt would be to miss the forest for the trees. Instead of merely adapting, a more accurate claim would be that these people experienced compensation.

There are many accounts in the scientific literature of visually impaired people experiencing similar compensatory sensory changes. Evidence suggests that the compensatory enhancement phenomenon is a result of something known as crossmodal plasticity.

Crossmodal plasticity refers to the alterations that occur involving the reduction of input from one sensory organ, resulting in the increased usage of another [Kral, & Sharma 2023]. Although such a compensatory sense-heightening alteration may be an evolutionary mechanism that probably occurs to boost the individual's chance of survival, there are limitations. As with all things, limitations as to how much compensatory enhancement can be achieved for certain functional sensory aspects exist, and in exchange for the enhancements permanent impairments will indeed affect other aspects.

While there is no way to accurately quantify how much influence blindness has on crossmodal compensation, the level of superior compensatory hearing that develops if compared to seeing peer controls would undoubtedly be considered auditory giftedness. Even though the process of crossmodal plasticity does occur to some degree in those who experience the loss of at least one sensory modality (e.g., vision in this case), the extent to which the increased usage of the other sense organ develops varies from one nongenetically identical person to the next. In addition to innate genetic differences as a possible explanation for variation, since the extent to which an individual's hearing develops is inextricably linked with the hearing ability that develops in response to the absence or loss of vision, the other aspect that could comprise part of an equation accounting for variation is the sensory modality loss itself. That is, the extent to which the hearing ability develops (i.e., giftedness) may be correlated with the extent to which the lost vision experienced detrimentally impacts the individual. For instance, if someone who loses their vision primarily relied on it so that in its absence there is an enormous void to fill, then the hearing that develops must make up for the loss by developing to an extreme level. Though possible does not imply actual, from a logical standpoint it does at the very least allow us to assume it to be the case.

The author hypothesizes based on the evidence for crossmodal plasticity that since the extent to which an ability develops appears to be inseparable from the development of the ability itself, which is eerily similar to my argument concerning how conditions that result in disability are inseparable from the disability itself, there is at least one example in which the loss of sensory modality creates the experience of disability in response to which occurs crossmodal plasticity resulting in alternate sensory organ enhancement to a level that would be considered gifted. Furthermore, it is in the absence of one sensory faculty that developing another of the remaining senses helps someone: by allowing them to resume daily activities, affording them the best chances at survival.

Given the evidence for crossmodal plasticity and the varying degrees to which it can manifest with respect to sensory compensation [Sela 2014; Mattioni, et al. 2022; Auer, et al. 2007; Sharma, & Kyong 2020], it becomes plausible that the shift from disability to gift in terms of the sequence of events could be considered a benefit [Mattioni, et al. 2022; Auer, et al. 2007; Sharma, & Kyong, 2020]. This is because the disability experienced due to the loss of one sense modality is not merely counterbalanced but exceeded through the heightened development of another modality, thus affording those with such disabilities more capacity to manage their lives effectively.

As pointed out, visually impaired individuals exhibit markedly superior hearing abilities compared to their sighted peers [Kilian, et al. 2022; Levy-

Tzedek, et al. 2014; Kärcher, et al. 2012; Sorgini, et al. 2018]; this exemplifies how the onset of disability can lead to the emergence of gifts.

The crossmodal development of gifted hearing is not only compensation for the loss of vision but also an evolutionary strategy for survivability [Sela 2014; Tanguay, et al. 2020]. As discussed, the extent of this heightened auditory ability is linked to the degree of impact the loss of vision has on the individual [Frenzel, et al. 2012]. For those who relied heavily on their visual sense, the auditory enhancement may develop to an extraordinary level, essentially gifting them with capabilities beyond the norm [Tanguay, et al. 2020; Sharma, & Kyong 2020; Mattioni, et al. 2022].

This phenomenon of crossmodal plasticity illustrates how disability and giftedness are not mutually exclusive but can in fact be two sides of the same coin. The reduction in input from one sensory modality triggers compensatory changes in the brain, reallocating resources to enhance the remaining senses. This is a testament to the remarkable adaptability and resilience of the human brain.

While vision loss undoubtedly presents significant challenges, it can paradoxically unlock heightened abilities in other areas. The author has correctly pointed out that individuals who lose their vision at an early age often develop superior auditory processing capabilities, to the point where their hearing can be considered «gifted.» This extraordinary enhancement is a direct result of crossmodal plasticity, whereby the brain compensates for the reduction in visual input by reallocating resources to boost the remaining senses [Sharma, & Kyong 2020; Tanguay, et al. 2020; Mattioni, et al. 2022; Auer, et al. 2007].

The extent of this auditory compensation appears to be closely linked with the individual's prior reliance on vision [Auer, et al. 2007; Tanguay, et al. 2020; Mattioni, et al. 2022]. Those who heavily depended on their visual sense before losing it often experience the most dramatic improvements in hearing, as their brain strives to fill the void left by the absence of sight. This suggests that disability and giftedness can be two sides of the same coin – the very changes that create functional limitations in one area can simultaneously unlock exceptional abilities in another [Tanguay, et al. 2020; Sharma, & Kyong 2020; Mattioni, et al. 2022].

Crossmodal development of gifted hearing is not only compensatory, but it also occurs when disability precedes the gift. When the events of disability and gifts occur in this order from a perspective of the aspect of order utilizing time as a framework the person seems to benefit. Considering the example of crossmodal plasticity given what happens in the order it occurs, there is no basis to suggest gifts could precede disability. In particular, if gifts were to precede disability, then the following questions would need to be answered: (1) How would it initiate without a prior loss of sense perception? (2) Which sense would be compensatorily enhanced if all were still present? and (3)

How would it know to what extent to develop without the disabling loss of at least one sense preceding? Unless these questions all can be answered, then gifts are unlikely to precede.

The importance of the compensation that occurs in crossmodal plasticity is paramount. Interestingly, according to the Oxford English Dictionary, by definition "compensate" means give or get something in recognition of loss, suffering, or injury; to make up for or offset a disability with development in another dimension or direction [Oxford English Dictionary, 2025]. Not only does one definition describe what we argued occurs, but the other definition has the word "disability" included! As a phenomenon, either interpretation of the term "compensate" entails some sort of need or purpose being fulfilled. Whether it be to make up for or offset or recognize in exchange for loss, when a phenomenon is appreciated in terms of a need they satisfy or a purpose they are to ultimately serve, the framework from which it is appreciated is referred to as teleological [Carroll 2023].

In adopting a teleological co- or sub-framework on gifts that views them by their very nature as being compensatory phenomena, then in the absence of any preexisting deficits that result in disability, there would be nothing for which the development of gifts could be said to compensate! Therefore, the development of whatever probabilistically contingent defects one is to have causing the experience of disability – both deterministic (i.e., 100% likely) and stochastic (i.e., 100% possible) – must take precedence to any gifts. Moreover, this sequence affords the best opportunity for self-corrective efforts, which occurs through the development of gifts that are compensatory.

Conclusion

This exploration of crossmodal plasticity reveals a compelling narrative of human potential that transcends the traditional dichotomy between disability and giftedness. By recognizing the brain's remarkable capacity for adaptation, we can begin to appreciate how the experience of disability, particularly sensory loss, can serve as an unexpected catalyst for the development of exceptional abilities.

The evidence presented suggests that crossmodal plasticity is not merely about compensation but can also be a pathway to extraordinary talent. When one sense is compromised, the brain redistributes its resources, often leading to a heightened acuity in other sensory domains. This compensatory mechanism, we argue, can result in abilities that surpass typical levels of functioning, blurring the lines between what we conventionally label as "disability" and "giftedness".

This perspective challenges us to reconsider our understanding of human potential as a spectrum of diverse abilities, where strengths and limitations are often intricately intertwined. By embracing a more inclusive view, we can

move beyond simplistic categorizations and appreciate the unique tapestry of human capabilities. Furthermore, recognizing the potential within disability can empower individuals, educators, and therapists to cultivate a strengths-based approach that fosters the development of exceptional talents, regardless of perceived limitations.

Further research is needed to explore the full implications of crossmodal plasticity for understanding the complex relationship between disability and giftedness. However, this exploration offers a promising starting point for challenging assumptions, sparking new questions, and ultimately fostering a more inclusive and empowering vision of human potential.

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***Ла Шун Л. Керролл*. Інвалідність як каталізатор обдарованості: дослідження кросмодальної пластичності та телеологічна основа для розуміння виняткових когнітивних здібностей**

Ця стаття ставить під сумнів традиційну дихотомію між інвалідністю та обдарованістю, досліджуючи потенціал сенсорної втрати як каталізатора виняткових здібностей в інших сферах. Спираючись на концепцію кросмодальної пластичності – чудової здатності мозку реорганізовуватися та компенсувати сенсорну депривацію – у статті стверджується, що люди, які відчувають сенсорну втрату, особливо в ранньому віці, можуть розвинути підвищені здібності в решті органів чуття, перевищуючи типові рівні функціонування. Цей аргумент випливає з розуміння того, що коли один сенсорний шлях порушений, мозок перерозподіляє нейронні ресурси для посилення інших сенсорних модальностей. Цей компенсаторний механізм, який часто спостерігається у людей зі сліпотою або глухотою, може призвести до по-

кращення перцептивних здібностей у таких сферах, як обробка слухової інформації, тактильна чутливість або просторова навігація. У статті пропонується телеологічна основа для розуміння обдарованості в цьому контексті, припускаючи, що виняткові здібності, що виникають внаслідок сенсорної втрати, виконують компенсаторну функцію, дозволяючи людям ефективно орієнтуватися у світі, незважаючи на їхні порушення. Ця перспектива ставить під сумнів уявлення про обдарованість як виключно вроджену рису, підкреслюючи значну роль чинників навколишнього середовища та нейронної адаптації у формуванні людського потенціалу. Представляючи докази існуючих досліджень кросмодальної пластичності та окремі приклади людей із сенсорними порушеннями, які розвинули надзвичайні здібності, стаття заохочує більш нюансоване та інклюзивне розуміння людського потенціалу. Зрештою, стаття закликає до подальших досліджень, щоб повноцінно дослідити наслідки кросмодальної пластичності для розуміння складного взаємозв'язку між інвалідністю та обдарованістю, виступаючи за підхід, заснований на сильних сторонах, який визнає та розвиває унікальні таланти всіх людей, незалежно від уявних обмежень.

Ключові слова: *інклюзивне розуміння людського потенціалу, когнітивні здібності, інвалідність, обдарованість, кросмодальна пластичність, компенсаторний механізм, телеологічна структура, чинники навколишнього середовища.*

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