Brain Development and Autism, Explained

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Abstract

The process of brain development has not been clearly understood. So has autism. The lack of understanding has been a barrier for educators to develop strategies. Thus, understanding how a brain processes information must be illuminated prior to any pedagogical approaches. In this paper, both the process of brain development and autism are explained. Also, common effective educational strategies for all types of people will be discussed regardless of differences in their brain developmental stages.

1. Introduction

The thinking process of the human brain has been a mystery. Because of this, brain development is still left to individuals. Some could develop a high level of brain function, as seen among geniuses, while some struggle. Educational sectors have had difficulties identifying where the differences are coming from and how to close the gap, especially for people with autism-like brain developmental issues. As research groups bring different results and outcomes from various approaches, all seem to work well individually. But not in general. And there has not been a clear understanding of why.

The human brain has more than one thinking process. Depending on individuals, some might use one more than others. It can be compared with a left- or a right-handed person. A right-handed person could use his/her right hand more freely over the left hand. There are more than two different thinking processes in the human brain. The primary thinking process differs among individuals, like left- or right-handed. If an educational strategy focuses on a right-handed person, it might not be suitable for a left-handed. The biased educational approach is where autism-like brain development-related issues come from. The strategies are not ideal for the people. Thus, understanding the brain developmental process must be discovered to develop educational methods.

This paper will start with the process of brain development and the differences in thinking processes, then discuss brain developmental issues with autism. Lastly, regardless of the differences in their main thinking processes, novel educational strategies for all people will be reviewed.

2. The process of brain development

There are several different thinking processes in the human brain. It is the result of evolution. Some are the same as other animals' thinking processes, and some are unique to the human brain. An individual's brain development since birth follows the cycle of brain evolution. In the beginning, a survival instinct is primary brain function. As it develops, it gradually strives toward brain functions that are unique to humans. In general, education targets the development of human-only brain functions. However, because of a lack of clear boundaries, it struggles. Thus, drawing the line between human and animal brain functions is crucial for education.

2.1. Emotions as an early stage of brain development

In the early stage of brain development, emotions and social skills play an essential role. Since babies are yet to speak, they must rely on emotions and social skills for communication. These skills are common for many animals with brains and are essential to increase survival chances. However, emotions do not require a thinking process. In this paper, the thinking process is a series of thinking with reasoning only. Emotions are mainly direct responses to external inputs. Thus, they are called 'one-dimensional information processing systems' and cannot be considered a thinking process. However, in the initial stage of education, emotions are used to teach young generations by giving approval or disapproval with emotional signals. This teaching method is the first choice since there is no other way to teach until language skills are developed.

Teaching with emotions is effective but has a limitation for brain development. It might hinder the next step of brain development. Emotions and social skills at this stage are for survival. Whichever satisfies the survival conditions is correct. In other words, it lacks logic. The primary function of the human brain is the capability of logical thinking. Teaching with emotions might interfere with logical development.

However, evolution has forced brains to evolve further with social skills, except for children with autism. Children with autism have emotions for survival but lack social skills. Due to this, their brains cannot advance to the next developmental stage.

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2.2. Development of language skills

Emotional and social skills are firmly bound and developed together at the beginning of life. As language skills develop, emotion, social, and language skills work together for survival. Strictly, language skills for survival are yet signals. For humans, the signals are more complicated than for other animals. Youngsters learn language by mimicking adults and using them. Even though it is not as complex as humans, other animals also learn to signal each other for survival. Language skills in this stage do not include a thinking process still.

The language learning process of humans can be compared with lion cubs building hunting skills. Lion cubs practice hunting skills as they play. The foundation of the behavior is emotion-based social skills. In this way, they can survive in the future. For humans, it is the language skills that are essential for survival. Thus, children start building language skills while they play. And language skills are built over emotion-based social skills, just like other social animals. However, emotional, social, and language skills are insufficient to increase chances of survival.

Because challenges are waiting, lions must challenge their prey for survival, even if the hunting is risky. Only with the success they can sustain their life and bloodlines.

2.3. Development of a purpose-based thinking process

Once social and language skills are built, it is time for challenges. It is still for survival. Children's social interaction is not limited to simple play anymore. They play games. Games have winners and losers. Children play games to win. Brain development accelerates at this point. Children are actively seeking competition. The competition promotes brains to think. However, the thinking is still passive. The thinking process can only be triggered by the purpose of satisfaction. There are challenges, but they are not risky. This is where the human brain and animal brains are branching away gradually. But they still share many similarities.

In 2014, Jelbert et al. reported that the New Caledonian Crows have a causal understanding of water displacement, and their brain is similar to five to seven-year-old children [1]. This research shows that animals can also use thinking processes to fulfill their satisfaction, just like humans.

At this stage, the thinking process relies on gaining knowledge from direct observation. The process of knowledge building from observation is referred to as the 'two-dimensional thinking process' in this paper since it is a process of gaining knowledge by connecting a result with the cause by understanding. Unlike the one-dimensional information processing system, the two-dimensional information processing system is a thinking process but still primitive. This process is named a 'purpose-based thinking process' in this paper. The purpose-based thinking process works toward survival and satisfaction at the same time. Knowledge is a crucial factor in the thinking process. For example, storing food to prepare for the harsh season ahead is one of them. Knowledge about seasonal changes must be in the memory. However, the thinking process is limited to direct observation, as in dropping gravel to raise the water level. This thinking process functions best when there is an instant reward or satisfaction.

The human brain is larger than the New Caledonian Crows' brain. The difference is not just the capacity of memory. The critical factor that separates the human brain from other animal brains is the capability of questioning. In other words, the same purpose-based thinking process branches out into two different paths because of the questions. The reason that the human brain could evolve further is the question.

2.4. Evolution of a goal-based thinking process

The goal-based thinking process was named such because a brain starts functioning with a goal to achieve. There are challenges involved as well. And it is responsible for the exponential growth of knowledge.

Unlike animals, simple survival and reproduction are not the only purposes of human life. The reason for having an education is that the human instinct is to complete brain evolution through brain development. The human brain needs something more challenging to develop the brain further toward completion of brain function. That is the challenge beyond direct observation.

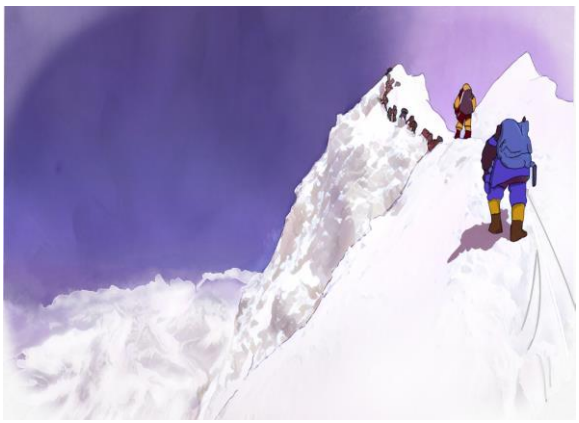

Figure 1. Challenging Everest

For example, if anyone would like to climb Mount Everest, they have to be prepared ahead (Figure 1). To

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achieve the task in Figure 1, it requires a series of thinking processes such as goal setting, observation, data collection and analysis, predictions, hypothesis, tool developments, etc. One has to examine weather conditions, gears, supplies, etc. The preparation step requires observation, data collection and analysis, hypothesis, predictions, experiments, development of tools, imagination, and many more. This thinking process is what education is aiming for. Once a goal is set, the thinking process advances to gathering data to analyze, predict, and theorize after testing.

However, teaching a goal-based thinking process is not as simple as it sounds. The reason is that it has to be the students who need to develop this thinking process. For example, if a person wants to climb Mount Everest, it is the person who has to figure out the entire process. If the person relies on an expert, the person might get experience with Everest but cannot develop the thinking process. This is a dilemma in the current educational system. The typical teaching methods deliver the methods as knowledge. Teaching what and when to do something is an example. Teaching methods must be debate- or discussion-based to develop the goal-based thinking process. One of the examples of teaching methods to build an active goal-based thinking process is from Professor Michael Sandel at Harvard University [2]. This type of approach is effective in prompting a goal-based thinking process. However, it also has limitations. It cannot cover various topics. Since the class is debate- or discussion-based, the amount of knowledge must be traded off. The tradeoff means that students who learned this way would have difficulties fitting into any educational system that measures students' academic achievement by exams that check the accuracy of knowledge.

There are ways to improve teaching methods which can handle both the amount of knowledge and the development of a goal-based thinking process, as discussed by Min [3]. The strategies suggested in the paper will help students to develop a goal-based thinking process effectively.

3. Autism – a different way of thinking

The goal-based thinking process is unique to humans but still evolved from standard brain functions found in animals. For people with autism, since their social skills are not well developed from the beginning, the entire brain developmental process discussed up to here cannot be expected to occur naturally. This is why it is rare to find people with autism in a higher-level educational system. Their thinking process is different from others. A goal-based thinking process requires social interaction from common senses. For example, when a cup is observed, it triggers the thinking process of a common sense of purpose like 'for drinking' or 'to contain liquid.' In other words, observations directly stimulate a purpose-based thinking process from a common sense, then advance to goal-based thinking, as discussed in sections 2.3 and 2.4. The transition from a purpose-based thinking process to a goal-based thinking process is carried out by curiosity by identifying problems, patterns, or differences from comparison. Curiosity promotes the further development of social and language communication skills to find answers to curiosity. The purpose-based questions are responsible for initial language development. However, the questions are not as effective as curiosity questions for language and brain development. Since the purpose-based questions are related to usage, they are not considered curiosity questions.

By translating curiosity into questions, methods to answer the questions can be followed. Thus, the goal-based thinking process is the point where language development accelerates. Due to a lack of social skills, the chain reactions of brain development do not occur spontaneously in autistic people.

According to the person with autism, one of the authors of this paper, the start of the thinking process is different even in the observation. Instead of moving to purpose-based thinking, he focuses on details such as colour, shape, etc. This is similar to Dr. Temple Grandin's way of thinking. Dr. Grandin also has autism, and she is a well-known biologist. She described her ways of observing and thinking process as focusing on details and picture thinking [4][5]. The differences in thinking come from the link between observation and the thinking processes. Observation with detail is translated to picture thinking for autistic people but to purpose-based thinking for others. Thus, we have investigated this deeper to understand the thinking process of people with autism.

3.1. Illumination of autistic thinking process

The purpose-based thinking process is part of brain evolution. To survive, humans must think of the purpose of any objects and use them as tools. In other words, the development of tools is based on purpose-based thinking. Thus, any observation can trigger a purpose-based thinking process to develop tools spontaneously. However, for people with autism, observations do not initiate purpose-based thinking. It stimulates picture-based thinking. Picture-based thinking is not simple picture-based thinking. It is a movie or virtual reality-like thinking. It can be a two-dimensional or a three-dimensional cartoon or virtual reality. It seems that thinking patterns change over time. As time passes, cartoon-like thinking is reduced, and virtual reality-like thinking is increased. This thinking process is a simulation based on observation. For example, virtual reality-like fish movies play in their brains as they look at a fish tank. So, this made them stay longer with one object than others since watching a film in their brains. Playing movie-like

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images could cause others to think that people with autism are weird. They sometimes laugh at even an accident where people get seriously injured. However, it is not that they are not aware of the seriousness. It is because fun movies or cartoon-like images similar to the accident overlap in their brains. They laugh at the movie playing in the brain.

As mentioned earlier, it is a thinking process of simulation. The only difference is without proper control. The question is whether it is something new in brain evolution.

3.2. Tradeoffs in brain evolution

The evolutionary tradeoff is a well-known concept [6]. Brain evolution could be explained with the same concept. Picture thinking is built into all human brains. Dreaming is an example. People with autism are strong in 'thinking in pictures' and weak in 'thinking in language.' The tradeoff can be compared with left-handed and right-handed. However, there could be more different thinking processes which are not well known yet. One of the examples is Albert Einstein, who seemed to think in music often [7]. As 'thinking in pictures' is a process to simulate phenomena in pictures, 'thinking in music' must be another process to simulate phenomena. But the question is why humans have these different types of thinking processes.

The ability to create new concepts is one of the known geniuses' thinking processes [8]. As discussed in the chapter, there are two types of creative thinking (type I & type II). Type I is creative thinking to develop new technologies based on new ideas, and type II is creative thinking to create new concepts. Since they are the thinking processes to create new concepts, they require a thinking process beyond language thinking. One of them is picture thinking, as discussed in the chapter. This implies that geniuses can provoke language and picture- or music-thinking processes. But the question is how geniuses did.

4. Education for people with different types of thinking processes

The current educational system is fitted to people with language and the goal-based thinking process. Language thinking has evolved with the purpose-based and the goal-based thinking process. Other than humans, animal brain function is concentrated on purpose-based thinking only. Animals can use, learn, and teach how to use tools from the brain function of purpose-based thinking. However, communication at the animal level can still be considered as signals and gestures, even complicated and sophisticated, as in chimpanzees [9]. For humans, language skills evolve from this point because of questions. Thus, the purpose-based thinking process is intermediate between humans and animals.

Human language skills branched out from signals because of questions. The foundation is the same purpose-based thinking process. However, turning the observation into purpose-based questions opened a new chapter for humans. For example, when there is a hammer, questions like 'What to do with it?' triggers brains to think and find answers to the questions, then describe entire thinking processes in language. In this way, humans could build language and communication skills together.

Another factor that advances language skills to another level is curiosity. For example, when there is a flashlight, purpose-based thinking spontaneously makes the human brain think from question to use. However, when there is a problem, the problem identification sparks curiosity to solve it. Language development jumps to a different level with the thinking process to solve problems. The brain development is closely connected with language skills. In short, problem or pattern identification or noticing differences from observation triggers curiosity, which has to be translated into questions to initiate a thinking process to find answers. Then, the whole thinking process can be described with language.

The thinking process of people with autism starts differently from the beginning. Thus, language development based on goal-based curiosities cannot be expected. Even without autism, for some people, there could be a chance that thinking processes are hung in purpose-based thinking instead of advancing to goal-based thinking. They might show some language skills but are not adequately developed since the brain mainly processes information with purpose-based thinking. The question is why education cannot systematically teach these people, including autism, to build language skills.

4.1. Curiosity-based thinking

The difference between the purpose-based and the goal-based thinking processes is curiosity. The current educational system is having difficulties because there are no known ways to turn curiosity on systematically for students. Curiosity-based thinking is not learnable and teachable. Because of this, the development of curiosity-based thinking has been left for individuals to provoke until now. Current education focuses on gaining knowledge. Problem or pattern identification or noticing differences are the source of curiosity and cannot be expected without knowledge. Thus, the educational focus is on delivering knowledge. More knowledge means more thinking processes. However, even with people thinking in language, not all people adapt well to a knowledge-focused educational system. Many students struggle in school. And it is worse for people with autism or with other types of brain-related

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developmental issues. This is due to a lack of systematic approaches to turn curiosity on.

For some people, translating observation into curiosity is a spontaneous response when there is a problem or a difference from comparison. Thus, goal-based thinking from these types of curiosity is relatively straightforward. However, curiosity from pattern recognition might be limited to some people. Many others might struggle even in this stage. There is one more difference in a genius thinking process – the thinking process to find answers to curiosity questions, which is beyond knowledge-focused education. Once again, this was left to individuals because the thinking processes were not learnable and teachable.

Education aims to develop students' brain function regardless of their preferred thinking processes. However, the effectiveness varies among individuals because there have been no pedagogical approaches to turn curiosity on systematically.

4.2. Systematic development of the curiosity-based thinking process for all

Curiosity was not learnable and teachable because it lacked systematic translation of observation into curiosity and thinking processes to answer the curiosity questions.

As described throughout this paper, there are steps in brain development. Each step relies on the step before. However, there is a common factor in the start of thinking processes. That is 'observation'. An autistic person starts thinking in pictures as they observe objects or phenomena. This is the same for the people thinking in language. The purpose-based and the goal-based thinking processes start from observation as well. Thus, translating observation into curiosity systematically will work for all types of people regardless of current brain developmental stages. Then, the most significant educational barrier will be removed.

Observation does not translate into curiosity without problem, pattern, or difference recognition. And this cannot be provided by current educational systems. Education starts with problems, as shown in scientific thinking [10]. The missing part is the translation process from observation into problem, pattern, or difference recognition to turn curiosity on. Since the current educational approach relies on curiosity, provoking thinking processes is left to individuals.

However, the process has to be reversed to force a brain to translate observed information into curiosity. Questions must be generated from observation to turn curiosity on. One problem is that not all questions can translate observation into curiosity. There are specific questions for the process, curiosity questions. The curiosity questions should be based on observation rather than looking for answers. For example, 'What should I use this cup for?' is not a curiosity question, while 'Why is water transparent?' is.

Curiosity questions are essential for developing higher language skills, brain, and thinking processes. But still, the thinking process to find answers must be followed.

The systematic methods to activate curiosity and thinking process to find answers to the curiosity questions have been discussed in the following paper and booklets [11][12][13]. In short, the steps are questions to observe, observe, describe, summarize, reasoning questions based on summaries, comparison, describe comparison, and question-based hypothesis. It also includes the conceptualization of knowledge. Turning the observation into reasoning questions is the step that forces the brain to turn curiosity on. The following steps to construct a question-based hypothesis are steps to find answers to the curiosity questions. With these methods, anyone can develop thinking processes regardless of brain developmental stages.

5. Conclusion

The focus of the current educational system is on goal-based thinking processes. It is a natural evolutionary process for the human brain to be biased toward purpose-based and goal-based thinking processes. The reason that these thinking processes are in the mainstream in human societies is because of survival instinct. Finding and developing tools are essential brain functions to survive in competition, including against hostile nature. For example, farming, hunting, and making shelters are natural survival instincts. Also, the development of tools for battlefields is part of human history, which has been another essential brain function to survive. The competition among societies is more responsible for the goal-based thinking process becoming the mainstream of brain evolution because winners need to conceal their tools and technologies within them. They suppress losers not to advance beyond their capabilities. Thus, other thinking processes that hold potential for creative thinking are discouraged historically.

An increased number of people with different types of thinking can also be a natural evolutionary process. As the population grows, competition gets severe. The highly competitive world pressures the brains to evolve since goal-based thinking is on the plateau. This situation brings the need for ventilation, and different types of thinking processes are the ones. The only problem with different thinking processes is missing educational strategies for their brains to develop.

People with different thinking processes have been categorized as disabled in many cases. It is understandable since they have difficulties harmonizing with the societies to which they belong.

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In addition, many are not able to cope with average life. However, the need for support does not mean their brain function is delayed. The reason that they show delayed brain development is due to a lack of educational strategies. The capability of brain development has been left for individuals to provoke until now.

This paper discussed the processes of brain development and different thinking processes. Also, systematic teaching and learning methods have been reviewed. Since the mystery of human brain development has been illuminated, it is time to go deeper and change the world of education.

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