

Unlocking Language and Brain Development in Autistic Children

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Abstract

Families with autistic children have often faced significant challenges due to a lack of effective educational strategies. Language development in these children is limited, and consequently, brain development is also constrained. Since communication is fundamental to brain development and language skills are primary tools of communication, such limitations are inevitable. To date, the development of social skills has been a primary tool in promoting language and brain development in autism education. However, the success rate is not high. This is because it is mainly from a conceptual confusion between language and signals. Training children through social skills primarily targets signal-based communication rather than language. Transforming signals into language requires a distinct set of educational methods: conceptualization. Focusing on social skills cannot directly stimulate the development of linguistic skills in autistic children since it lacks systematic conceptualization processes. Instead of social skills, educational strategies that lead children to make decisions independently have a more direct impact on their language and brain development. In this paper, we present novel, systematic strategies that are designed to develop language and brain function in children with autism.

1. Introduction

The thinking processes of autistic people are different from those of neurotypical individuals. They tend to think in pictures. Picture thinking can be even more diverse among autistic people, as discussed in the paper submitted alongside this paper [1]. Picture thinking is not a single, uniform phenomenon. It seems autistic people share a common picture thinking style, such as immersive virtual-reality-like picture thinking. However, there are also differences. Some may think in patterns, whereas others do not.

Picture thinking could be a powerful simulation tool when it is under control, as Dr. Temple Grandin (a scientist and professor with autism) discussed [2]. On the other hand, uncontrollable picture thinking could trigger emotional separation and cause behavioural issues. For example, while ordinary people show sympathy in a sad situation, autistic individuals could be laughing because animation-like fun images appear in their brains. Emotional and behavioural separations can be a sign of reduced

social skills, but they are not a sign of limited logical thinking skills. In other words, logical thinking is not prohibited by picture thinking. As discussed above, Dr. Grandin showed that picture thinking could be a powerful simulation tool in invention. Since evolution is considered to involve trade-offs [3], picture thinking could result from a trade-off in social skills.

Training to develop social skills has been a significant approach in autism education [4][5][6]. Considering that autism spectrum disorder is a result of the trade-offs in interpersonal skills and picture thinking, the educational strategies focusing on social skills might not be suitable for autistic people. Thus, our development focused on language and brain development from a different direction.

2. Differences between signals and language

Signals include sounds, facial expressions, gestures, etc. A signal is used to send direct messages, such as a warning when danger is nearby. In humans, the concepts of signals and language are somewhat mixed. Listening and repeating 'close the door', for example, are signals. To translate signals into language, individuals must break down the words, identify the concepts in each word, and then combine them to express their thoughts. This thinking process is defined as 'conceptualization'. In other words, without conceptualizing the words 'close' and 'door', simple repetition of the phrase is a 'signal'.

Neurotypical children learn word meanings by encountering each word across many different contexts. For example, exposure to phrases such as "close the window" and "close the drawer" helps the child's brain associate the word "close" with the action itself. In this case, the action refers to restricting access to a space by using an object such as a door or a drawer. In essence, neurotypical children learn language by linking words to the methods or actions they represent. This is the same strategy used to build summation skills in calculation. Having children practice many different combinations is the process of making connections between the summation as methods and the results. For children to follow this learning process, social skills are essential. They need to observe, copy, paste, and practice. Children also learn to connect words to the factors involved.

Neurotypical children can connect words to the relevant methods or actions by observation. They can

listen to and watch each other to imitate. This process is enforced further by education. Then the children begin to combine words. Social skills play a critical role in both imitation and education. Without observing others, neither imitation nor education can happen. Neurotypical people have an instinct to be part of society. This instinct encourages them to observe, imitate, and learn through practice. This is the problem with autistic children. They are not social enough to make connections between words and methods or actions by imitation and education.

Autism occurs from differences in the thinking processes. As mentioned earlier, they tend to think in pictures. When they are young, there might not be enough information for their brains to visualize. However, as visual information is accumulated over time in the brain, picture thinking can be enhanced. This affects their responses to real-world events.

In a neurotypical individual's brain, sensory inputs often directly stimulate emotions and desires. For example, smelling a pizza triggers the desire for pizza. However, in the autistic brain, the same sensory input could pass through an image or a cartoon-like movie clip before the emotions and desires.

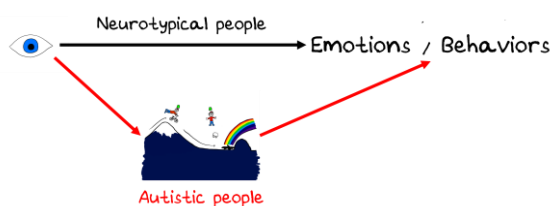


Figure 1. Showing picture thinking step added in an autistic person's brain

The sensory input that promotes picture thinking could be anything. It can be a loud sound, a scene of an accident, or even a word. Since emotions are associated with images in the brain, the sensory input from the scene itself might not be directly linked to emotions as it is in neurotypical people. This prevents autistic individuals from observing others. They have their own scene to observe in their brains. Since emotions respond to images, autistic individuals could show different emotions from others. Consequently, they started to be isolated. Inhibiting the picture thinking through medication might provide some solutions. However, this might not guarantee that the sensory input is directly translated into emotions as planned. It might exacerbate disconnection and isolation, as the link between sensory input and emotions is lost.

Neurotypical children can build social skills from emotions and desires directly linked to real-world observation. If they are not provided with what they want, they would experience emotional fluctuations. The unstable emotions then activate social skills to find solutions. Social skills could force the individual to observe others to mimic them, to find tools, or to

think of methods. In this way, neurotypical children can build knowledge and skills. The experience of success will enhance social skills and lead to greater knowledge and skills. To achieve the desire for knowledge and skills, they need to find knowledgeable people. Admiring people who hold extensive knowledge and skills is also a social skill. It motivates individuals to follow the path of their idols. Emotion of jealousy also works in the same way.

The problem with autistic people is that their social skills are not fully functional, and the pathway of information processing is different.

3. Language and brain functions beyond social skills

Language skills are directly associated with brain development and span many levels. The most primitive level is replacing and combining words and phrases using knowledge and skills. More knowledge and skills allow for various combinations. In the academic field, this brings challenges. Students can write an essay or a paper by combining the knowledge that they have. However, without their own thoughts added, their writing will fall into plagiarism. The increase in plagiarism cases indicates that students' language skills are at a primary level. To develop higher-level language skills, more than just social skills are required.

Social skill-based language skills have limitations. Social skills facilitate learning by the fast accumulation of knowledge and skills, but do not promote thinking on their own. This is because 'self' is missing. Thinking on their own means thinking by themselves. It is different from learning knowledge and skills.

Provoking a higher level of language skill and brain functions requires 'self' – one's own idea. New thoughts and ideas produce novel and distinguished outcomes. The importance of 'self' is well addressed in metacognition [7][8][9]. Metacognition is not a new concept in human history. The term 'realization' is also pointing in the same direction. The differences between metacognition and realization are in the process. Metacognition is more thought process-oriented, while realization is results-oriented. Since there is no result without a process, the two terms should be merged into 'metacognitive realization', a new term that combines the process and the result together, which will be used hereafter to address the self-awareness-based thinking process. The concept of metacognitive realization needs further development, as specific methods for achieving it have not yet been fully addressed. Due to a lack of methodology, provoking metacognitive realization depends entirely on individuals. There are no results without methods. The same methods rarely produce various results. In other words, if methods are similar, results are also similar. At this point, one thing is

clear. Higher brain function can be achieved by the metacognitive realization process rather than social skill-based learning and teaching. The questions are where it originated, how to systematically activate the thinking processes, and how it relates to autism education.

4. Decoding brain functions behind logical thinking

The key to metacognitive realization is clear. Individuals must be aware of their own thinking processes to realize. The thinking processes referred to here are not just any thinking processes. They must be logical. Only then can metacognitive realization occur. However, without specific methods to provoke logical thinking, the concept remains vague.

Logical thinking is a process of reasoning. Reasoning arises from questions, and questions arise from curiosity. However, there are different types of curiosity and questions. The first type of curiosity and questions is the 'knowledge-seeking curiosity and questions'. Knowledge-seeking curiosity and questions are social-skill-based. Individuals have a desire to learn knowledge and skills to belong to society and survive. Since the learning process requires interactions with knowledgeable people, social interaction is essential.

The second type of curiosity and questions is to explore the unknown through experience. The unknown cannot be taught or learned since it is not known. Thus, social skills are not required for exploring the unknown. In addition, methods to explore the unknown are not known. Thus, methods must also be created. Since knowledge and skills are developed through methods, education focuses on knowledge and skills alongside the methods used to obtain or create them. However, the same strategy is not applicable to the unknown. It is up to individuals to find or create new methods for discovering and developing knowledge and skills. Conventional education, which focuses on knowledge and skills, cannot contribute to this process. In other words, curiosity and the questions required to explore the unknown are not teachable or learnable.

The methods to activate creative thinking have been known as concept building and concept connections [10][11][12][13]. These methods are the only methods available for the human brain to activate concept-based curiosity and questions. Concept-based curiosity and questions are higher-level brain functions. It systematically turns curiosity on and provides methods for processing information by translating curiosity into questions. These methods can be applied to individuals' self-learning processes. This is also referred to as 'learn how to learn'. By following the steps outlined in the published papers and books, individuals can train themselves to activate these higher brain functions.

The most important fact about concept-based curiosity and questions is that the processes do not require social skills. Social skills could be an asset during collaboration. However, thinking is left to the individuals. Since autistic people's logical thinking appears to be unaffected, methods of concept building and connections for developing logical thinking should be suitable for autism education.

To expand concept-based curiosity and questions from a self-learning tool to teaching strategies, concept building and concept connections should be individualized. Individualized education could be delivered in a regular classroom setting for neurotypical children. However, autistic children would have difficulties to learn in this environment. To proactively engage in classes, their emotions and behaviours should be under control, and they should be ready to interact with others. The most effective way of delivering individualized education is through parents' training.

5. Design and the application of concept-based education for autistic children

Autistic children have reduced social skills. However, the social skills do not seem to affect logical thinking, as seen in some people with autism. This suggests that developing logical thinking could promote language and brain development, even in children with autism. Concept-based thinking processes are methods for developing logical thinking. Thus, training children with a concept-based education will eventually connect them to the real world.

The key factor in brain development is self-awareness, as discussed in metacognitive realization. The same principle should be applicable to autistic children. If they can be aware of themselves, their language, and their brain should develop. As their brains develop, their emotions and behaviours can also be controlled.

Development of teaching methods carried out by applying a concept-based learning [14] to concept-based teaching. In the article, brain development is categorized into six levels. 1. Basic instinct, 2. Purpose-driven brain function, 3. Goal-oriented brain function or thinking, 4. Critical thinking, 5. Type I creative thinking, and 6. Type II creative thinking. The first two brain functions are not categorized as thinking, since most people cannot translate them into thinking proactively. The goal-oriented brain function or thinking is mixed state. If an individual applies simple trial-and-error strategies to achieve goals, it falls under brain function. It can be a thinking process when a concept-based approach is added.

Human brain development follows each step. However, provoking 3. Goal-oriented thinking, 4. Critical thinking, 5. Type I creative thinking, and 6. Type II creative thinking is very difficult. Brain

development of most people stops in either step 2. Purpose-based brain function or 3. Goal-oriented brain function. The reason is that these brain functions are based on social skills. Neurotypical people can use these brain functions naturally since social skills are a part of basic instincts. The same social skills inhibit the development of higher thinking processes.

Educational strategies were designed to convert brain functions into thinking processes. For example, the basic instinct-based brain function had to be converted into an instinct-based thinking process. The purpose-based brain function must be translated to a purpose-based thinking process, and so on. The tools used for conversion and translation were concept-building and concept-connection methods.

The teaching methods were delivered to parents with autism, and the outcomes were evaluated by parents' reports. Based on the reports, advanced strategies were provided. Then, children's progress was measured through behavioural changes, language development, and decision-making.

5.1. Educational strategies for autistic children

5.1.1. Implanting thinking to control basic instinct.

The emotions and behaviours of autistic children are driven by desires and picture thinking. Analysis of autistic children's behaviours shows two distinguishable emotions and behaviours. For example, 1. Driven by desires, they might be grabbing food from other tables at a restaurant. 2. The fear of an unfamiliar situation makes them anxious. Thus, parents were provided with two separate strategies. The key in this stage is asking children questions to help them make their own decisions. Self-awareness only happens when children decide what to do on their own. The questions also promote the children to develop communication skills.

Methods

1. Case with behaviours driven by desires: Planning earlier by asking questions to avoid unexpected behaviours from desires. – e.g. What will you do at the restaurant where we will dine in? Will you sit still on your chair? Etc.

2. Case with an unfamiliar environment: Describe the detailed procedures in a new environment. In dental care, providing detailed information about procedures in advance can help reduce fear.

5.1.2. Transforming the desires into purpose-based thinking. The decision-making step provides confidence and self-esteem. To push the brain to advance, the desires must be converted to a purpose-based thinking process.

The purpose-based thinking process helps children build concepts while fulfilling their desires. The key

factor in this step is the promise that their desires will be fulfilled. As children have confidence in getting what they want, they will follow their parents' lead.

Methods

Step 1. Turn children's desires into purpose. For example, if a child asks for chocolate, parents are advised to ask them for more details so that they can decide. This prompts children to develop concepts about factors in decision-making.

Examples: 'What kind of chocolate do you want?', 'How many do you want?' etc. For language development, parents were advised to wait for their children to answer.

Step 2. Ask questions to build concepts. For example, 'How many more do you want?', 'I am doing dishes. It will take about 10 minutes from now. Can you wait for 10 minutes?' etc. Showing how to measure 10 min duration using a clock will enhance the concept of time.

5.1.3. Developing goal-oriented thinking processes.

Desires and purpose are experience-based. For example, without ever having pizza, children will not desire it. Desire is the driving force behind the development of a purpose-driven thinking process. On the other hand, goals are something that they have not experienced, yet they are still based on experience. For example, a person who enjoys climbing mountains nearby may set a goal of climbing Mount Everest. Everest represents the goal. Achieving it requires preparation and overcoming challenges. The preparation and challenges are a process of goal-oriented thinking.

Developing a goal-oriented thinking process can be derived from a purpose-based thinking process. Going back to the pizza example, if a child only had cheese pizza, having pepperoni pizza can be a goal. Translating the goal into a thinking process is the process of developing a goal-oriented thinking process. To maximize brain development, predicting and simulating expected outcomes are recommended.

Methods

1. Suggest children with the same kind but different types of food, toys, or places by asking questions. E.g. 'You enjoy pepperoni and you like a cheese pizza. What would it be like if pepperoni were added to a cheese pizza? Do you want to try a pepperoni pizza this time?'

2. Ask questions for children to think about the outcomes. For example, 'Pepperoni is a bit salty. Will it make cheese pizza saltier?'

Prediction and simulation can go deeper as more concepts are built and connected. Also, picture thinking can enhance the prediction and simulation. However, utilizing picture thinking for prediction and

simulation requires control of the images.

6. Results and Discussion

Behaviour changes were immediate. It took less than a day for some and a week or two for the majority. The behaviours in unfamiliar environments also changed. This proves that children tend to follow the decisions that they made. Self-esteem is also increased.

Language skills started to improve as purpose-driven educational strategies were implemented. As children responded in simple words about what they wanted, they seemed to be confident in expressing their thoughts. The children can also build patience and grasp concepts used in daily life, such as time, day, and numbers.

The goal-oriented educational strategies were not fully implemented at this point. Since this thinking process requires both concept building and deep concept connections, the application can be used after purpose-driven education.

The results are based on parents' reports. This means they are not measurable in terms of numbers or percentages. Another reason for unmeasurable outcomes is the use of individualized strategies. Each family was provided with unique strategies for their children. However, the overall reports clearly showed that teaching children to build self-esteem is a crucial factor for language and brain development. As discussed in metacognitive realization, self-awareness is the key factor in education. One of the biggest challenges for educators is helping learners develop logical thinking. Logical thinking cannot be achieved by delivering knowledge and skills. The knowledge and skills might be essential for harmonizing within society. However, they undermine the development of logical thinking. Delivering knowledge and skills traps learners' brains in a limited area.

To promote the development of logical thinking, learners must process the knowledge and skills through conceptualization. Learners need to independently identify the factors that compose knowledge and skills. The only way to do this is through questions. Questions are the prompts that drive the brain to think.

7. Conclusion

In autism education, parents' roles are essential, as strategies must be individualized to suit their children. Questions also need to be tailored to be effective for each child. By individualizing the education, children can grasp the concepts of knowledge used in daily life.

To date, researchers have been struggling to develop strategies for autistic children. It is because processes of brain development, beyond social skill-based ones, were not previously known. Since the missing pieces have been identified and discussed in

this paper, a new chapter in autism education will begin.

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