

Effects of Cognitive Training Program in children with Autism Spectrum Disorder

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ABSTRACT:

Autism spectrum disorder is a neurological developmental condition significantly inappropriate development in social interaction, social communication, and repetitive patterns of behaviors, which may often persist in the person's entire life. The present study aims to ascertain the effect of cognitive training program to improve the cognitive functioning of children with autism spectrum disorder. A total of 20 children with autism spectrum disorder were placed in this study. A quasi-experimental single subject pre-post design was used to investigate the effectiveness of the cognitive training program to improve the child's cognitive functioning. The Color progressive matrices test of intelligence was used to measure the child's IQ, and the Indian Assessment of Autism Scale was used to assess the autism level of the child. The Cognitive Skills Assessment Scale was administered to measure the pre-post assessment of the child's cognitive functioning. The cognitive training module was administered to the children. It comprised executive functioning, cognitive mental states and central coherence tasks. Total 12 sessions of the cognitive training program were provided to the children. The results showed significant improvement in executive functioning, understanding cognitive mental states, and central coherence. The cognitive skills training program positively influenced the children's cognitive functioning.

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INTRODUCTION

Autism spectrum disorder is neurological developmental condition characterized by inappropriate development in social interaction, social communication, and repetitive patterns of behaviors (APA, 2013). Cognitive skills that focus on executive functioning, understanding the cognitive mental state of one's own and other, and central coherence. All these play a significant and critical role in the cognitive functioning of the ASD child. Cognitive functioning includes working memory, abstract thinking, visual processing, and processing speed, and also stated that individuals with ASD have an irregular pattern of cognitive abilities or skills. Executive functioning is a vast term that refers to a wide range of higher-order cognitive processes responsible for performing any activity or task. Executive functioning deficits have appeared in ASD children, such as working memory, cognitive flexibility, vigilance, and inhibitory control (Corbett et al. 2009). Pennington & Ozonoff, (1996) executive skills were not present from birth and also found not depending on experience during the early years of life in childhood, not even in adolescence phase of life. They found that the executive functioning deficit in autistic children. Many studies reported that it is either less able to organize their executive skills or become noticeable deficits in ASD children. Rabi, May, and Lek (2019) conducted study to investigate the effects of the cognitive training program in improving practical functioning skills in children with ASD. This study focused on cognitive skills in attention, working memory, transitioning, emotion regulation, planning, impulse control, cognitive flexibility, and problem-solving skills. The overall result concluded that a cognitive training program is one of the essential programs to help autistic children increase executive functioning skills. The result showed that cognitive training was significantly improved executive functioning skills among children with ASD was dependent on their ability. Dey and Banerjee (2017) reported that the executive functioning intervention training program is beneficial for improving the child's executive functioning. Gupta (2015) examined the effect of a semi-structured intervention program for improving social understanding, cognitive and adaptive functioning skills. The post-intervention result showed that the child has conceptually shown enhancement in thinking, expressing emotion, recognition, and enhancement in self-help general and self-help eating domains of social development. The intervention program based on cognitive techniques helped autistic children develop and strengthen mind reading. Flexible

cognition or cognitive flexibility entails the dynamic activation and modification of cognitive processes concerning changing task demands. Cognitive flexibility has a fundamental role in the development and successful use of communication, and cognitive flexibility skills need to be addressed as treatment. De Vries with other authors (2015) studied working memory and cognitive flexibility training for ASD children. Results reported that working memory and cognitive flexibility intervention conditions positively improved working memory tasks and levels in the flexibility task. Geurts, Corbett, and Solomon (2009) found that executive functioning and social competence both are related to the explicit and often artificial demands and constraints of executive functioning tasks, e.g., order a set of cards based on colour, shape, and number and compared to the dynamics of real-life social interaction. Lopez, Lincoln, Ozonoff, and Lai (2005) reported the executive dysfunction is the core feature in ASD. Literature suggested that control abilities that impair cognitive flexibility and a relationship between executive abilities. Executive impairment reflects abnormalities in the frontal lobe, responsible for the repetitive and restricted behaviour patterns in ASD children (Happé, 1999). Diamond (2013) defined inhibition as an ability to control attention, behaviours, and thought of persons, and inappropriate reaction required to be considered more appropriately is necessary while performing any activity. Working memory is a complex concept that can be operationalized in various ways, involves the storage of information over the short-term and strategic manipulation of information in the context of a specific goal or problem to be solved. Hughes (1996) ASD children performed motor planning significantly less compared to normal children. The cognitive mental state is the ability to understand own and others' cognitive mental states like intention and beliefs. Results revealed that theory of mind impairment in ASD children as defined by their poor performance on first-order false belief tasks (Boucher, 2012). White (2009) found that a substantial proportion of children with high functioning autism spectrum disorder performed similarly or even better than typically developing children and found that the advanced theory of mind understanding is less evident in the high functioning of ASD group. Miller (2009) found that children with ASD were failing to attend to or comprehend others' mental states may also include problems in understanding others' emotions. Cohen (2007) explored that individuals with ASD might learn to solve a task that trains them to recognize emotions. Ozonoff and Miller (1995); Baron-Cohen (1989) reported that ASD chil-

dren often have deficits in the theory of mind and have difficulty understanding the thought and feelings of other persons, and have difficulty understanding and being confused by other's behaviour. Research suggested that interaction, mainly in general skills, plays a crucial role in shaping the developmental path of autistic children's theory of mind. Baron-Cohen (1994) reported that deficits in the theory of mind might have their roots in unusual development of visual perceptual, cognitive, social, and emotional components and suggested that all these children's skills must be developed through training. Wellman (1994) found that cognitive mental states play a significant role in predicting and interpreting the actions of others. Cognitive mental states make understanding others behaviour and facial expressions mainly studied on the primary emotion. Mottron et al. (2006) studied two children with ASD and children without ASD. ASD children showed improvement in recognition, and they focused on how such altered face processing impacts emotion and perception. Further, they found that impairments may inspire emotional perception. These deficits may hamper specific domains of emotion. Celani, Battacchi, and Arcidiacono (1999) emotion recognition is a complex skill it requires the analysis of facial expressions in the context of social and physical, and autistic children often have difficulty in attending and integrating cues from different sources and also have a problem of interpretation of the meaning of the specific expression of the emotions, circumstance. Central coherence theory attempts to define cognitive phenomena of ASD in terms of a higher level of cognitive processing and included benefits that attempt to explain the deficits and the enhanced performance of ASD on specific tasks. Some of the phenomena that lead to the development of central coherence have prompted research in atypical attentional and enhanced perceptual processes in ASD. Persons with ASD often show characteristic profiles of strengths and weaknesses across the subsets of psychometrics tests. Poor performance on the test is usually taken as evidence of the cognitive impairment characteristic of ASD. There is also some evidence suggesting that somehow conceptual coherence might be intact in people with ASD. Central coherence theory predicts that individuals with ASD have difficulties seeing the significant and more meaningful picture and can partially use context in situations and found this to ambiguities picture. Although this central coherence has demonstrated a vulnerability in visual illusions associated with ASD, some aspects of visual perceptual performance are atypical. Performance appears to be more focused on complex

stimuli at the expense of the whole configuration (Mottron and Belleville, 1993). Quill (1997) reported that children with autism validate visual processing strengths and show diversity in their interests, preferences, and learning style. All these preferences were evaluated and taken into consideration while teaching social cognitive skills. Different learning styles can include construction tasks, games, role play, gross motor activities, reading or writing tasks, and drawing tasks, and children can practice social skills while working in small groups or large groups. Frith (1989) reported that persons with autism spectrum disorder might have less tendency to see the image presented in a particular situation and suggested that ASD children often show deficits in central coherence and show imbalance during processes and integrating information. They focus primarily on in-depth local information. All these may lead to perceiving the environment in a disconnected manner and avoiding processing a bigger picture.

Cognitive Skills refer to the use of cognitive tasks/activities to improve performance on the task. It is a set of systematic and targeted cognitive training tasks to improve several cognitive skills, including conservation ability, executive functioning, problem-solving ability, central coherence, and understanding cognitive mental state. As the deficits or difficulties in cognitive skills are the key characteristics for children with ASD, a lack of cognitive skills can influence their cognitive functioning. Cognitive training program's efficacy in improving attention and executive function in school-aged children with ASD (Macoun, Schneider, Bedir, Sheehan, and Sung, 2020). Cognitive training was significantly improved executive functioning of ASD children, it is one of the essential program to help ASD children to increase executive functioning skills (Rabi et al., 2019).

Therefore, an intervention focusing upon cognitive skills is essential to lead a better quality of life. At present, very little evidence regarding the utilization of cognitive skill intervention programs to enhance the cognitive skills of children with ASD have been conducted in India. Therefore, this study investigated the effectiveness of the cognitive skill training program of children with ASD.

METHODS

Participants: twenty children with ASD, aged from six to twelve years, in the rehabilitation clinic were placed in this study.

Instruments: The Indian scale for assessment autism (ISAA) was used as a screening tool to measure the level

of autism in children. The coloured progressive matrices test of intelligence was used as a screening tool to evaluate the IQ of the children with ASD. The Cognitive assessment test was used to evaluate the cognitive functioning of children with ASD. It measures four cognitive skills such as executive functioning, understanding cognitive mental state (ToM), central coherence, and Piagetian-based cognitive skills. It comprises of 36 items. The open-ended parent questionnaires were also used to collect feedback from parents regarding the effects of the cognitive training program, further directions, and recommendations.

Description of Cognitive Assessment Test: For this, a comprehensive review of cognitive skills was made. For this test, the researcher screened several tests developed in Indian and Foreign contexts. Furthermore, many theories related to cognitive were also reviewed, such as Jean Piaget's Cognitive Development Approach, Bloom's Taxonomy Theory, and cognitive theory of ASD includes the theory of mind, theory of executive functioning, and central coherence cognitive theories have been taken for its consideration. Children with autism spectrum disorder have difficulties and deficits in cognitive functioning or skills such as executive functioning, visual-spatial perception, understand other's and own cognitive mental states, conservation, classification ability, reasoning abilities, and other cognitive abilities like understanding, comprehension, application, synthesis.

Construction of cognitive assessment test, based on the above-given theories, and the literature review was made. A total of 77 test items were generated and sent to 15 experts and professionals working in ASD for its validation. Further, all 77 items were examined and scrutinized based on relevance, applicability, and specificity. A total of 64 items were finalized in both domains (cognitive and social skill). In cognitive skill domain, a total of 36 items were shortlisted after validating by taking the expert members to fine-tune the items, language, pattern, item sequence of each test item to finalize item formatting of the tool. The initial phase of the test was administered on a sample of 30 ASD children. After this preliminary administration of the test, editing of the items was made as suggested by the first attempt. The prepared test was

individually administered to a randomly selected sample of 50 children (male and female) of Delhi.

Validity, validity is a statistical procedure that studies the extent to which a test measures what the tool claims to measure. For this test, content validity has been considered, the following formula calculated quantitative analysis. The formula for determining the validity of this test is content validity, and quantitative analysis has been administered using the Content Validity Ratio (Lawshe, 1975). $CVR = (E/N) / (N/2)$. A total number of experts (N) Number who rated the object as essential (E) out of 77 items 13 items from the test have already been removed as those items show negative values. The remaining 64 items were finalized under both domains (cognitive and social) to assess the cognitive and social skills of ASD children for providing an intervention training program.

Reliability, after 20 days, the test was re-administered on the same sample to establish the test-retest Reliability of the tool. The reliability coefficient and reliability index for the test has been established by applying procedure of internal consistency reliability (0.93), indicating a high degree of internal consistency (0.62 to 0.81), test re-test reliability of tool (0.60 to 0.85) in the domain for the total score was 0.83 ($p < 0.001$).

Research Design and Procedures: mixed research design was used to investigate the effects of the cognitive skills program on cognitive functioning for children with ASD. The present study adopted the quasi-experimental pretest and post-test design and conducted the testing two times (before and after) to monitor progressive changes in cognitive functioning after the 12 sessions of intervention. The cognitive training program was conducted with 30-45 minutes per session.

The post-test was administered after the intervention program. Figure 1 is the framework of the cognitive skill program.

Intervention Program: this program has various features and advantages. First, the cognitive skill training program was designed based on existing literature and reviews recommendations for children with ASD. Second, it was a structured program specialized in cognitive functioning, which comprised four areas: executive function-



Fig. 1. Framework of Intervention.

ing, understanding cognitive mental state, central coherence, and Piagetian-based cognitive tasks. The cognitive skill program was conducted to enhance the cognitive skills and to see its effectiveness. This intervention provided the individual with a structured and well-organized worksheet, materials, and various teaching strategies.

Description of Cognitive intervention module, based on existing literature review, cognitive theories of ASD, social models of ASD, and recommendations given by researcher, expert opinion, tasks have been designed for enhancing cognitive skills in ASD children. The training aims to transfer skills that enhance the cognitive and social skill's efficiency of one or more than one target group of the trainees. The available literature review has revealed that Indian research on ASD mainly covers diagnostic issues and psychosocial factors. Cognitive intervention module is a structured, comprehensive and manually administered worksheet and material activities with 32 tasks.

Administration:

- Total of four trials of each task has been administered.
- Time and error were noticed during the conduction of activities.
- Cognitive domains: In this, a total of 5 domains have been taken into consideration, namely understand cognitive mental states, executive functioning, central coherence, and Piaget's cognitive approach, cognitive domain of Bloom taxonomy.
- The training module has covered all 32 activities.
- The total number of session is 12
- Duration of the training program is 30 -45 minutes for each session and the group sessions an hour for the session.

- To monitor the task-wise progress sheet observation/ activity sheet was prepared to enter activity, time duration, trial attempt, and error.

Content validity, the expert panel constituted for its validation included 4 rehabilitation psychologist, and two special educators. Every evaluator was rated on the domains like usefulness, appropriate in order to developmental milestone, cognitive domain.

1. *Intervention fidelity*, is defined as the degree to which an intervention or program is delivered as planned. Based on the conceptual model, implementing the fidelity framework includes integrating fidelity characteristics within an intervention, quality of delivery, and fidelity evaluation. All these factors may influence the fidelity of the intervention. In this present study conceptual model was taken into consideration. An intervention training manual which includes the structure of the program
2. A systematic measure of the program fidelity, such as time, attempt, and error on particular task (trials and error) scores
3. Training knowledge of the researcher
4. Validity fidelity using fidelity measures (activity progress sheet)

The present study followed these guidelines to support intervention fidelity. The researcher developed the activity progress sheet to measure daily sessions conducted on ASD children. Furthermore, to conduct an intervention program on ASD children, the researcher had the clinical experience to provide clinical services in a clinic setting. It ensured the quality of delivery of cognitive and social skills intervention training programs by the researcher.

Table 1. **Intervention Protocol**

Cognitive Task	Duration	Objective
Executive Functioning Task	10 Minutes	Enhancing cognitive skills
Understand Cognitive Mental State Task	10 Minutes	Enhancing Cognitive Skills
Central Coherence Task	10 Minutes	Enhancing Cognitive Skills
Piagetian Based Cognitive Task	10 Minutes	Enhancing Cognitive Skills

Table 2. **Data Collection Procedure**

Instruments	Participants	Pretest	Intervention	After the Intervention
Cognitive Assessment Test for ASD children	Children			
ISAA	Children			
CPM	Children			
Parent Feedback Form	Parent			

Data Collection and Data Interpretation: in this research study, quantitative and qualitative methods were used to see the effects of the cognitive training program on children with ASD. The quantitative scale was used to find the subjects' progress and changes during the intervention, and the qualitative approach was administered to addition the findings of the research. The cognitive skills assessment scale data were analyzed by applying a sample paired t-test to determine the difference between the pre and post-test scores regarding cognitive skills. Mean and standard deviations at pre and post time within each domain were calculated. The open-ended parent questionnaires were given to the parents to obtain information regarding intervention effects and to know the children's progress during the cognitive and social skills training program.

The specific objective of this study was to ascertain the effects of the cognitive training program on cognitive function in children with ASD. After collecting data, SPSS was used for data analysis, and it was implemented to analyze the pre and post-test data obtained by administering the cognitive assessment scale.

RESULTS

The effects of the cognitive training program on cognitive function.

Effects of intervention on Cognitive Assessment Scale: the cognitive assessment test was used to evaluate the cognitive skill change of children with ASD, and a sample paired

t-test was used to measure the effects of the intervention on cognitive skills. The results revealed significant differences among pre and post-test (before and after) scores for the intervention (all $p > 0.001$), suggesting that the dependent sample paired t-test is appropriate in this analysis. The result shows a significant difference in all the dimensions of cognitive skills in favour of post-test. Thus, the post-test mean was statistically significantly higher than the pretest mean. Cohen's d was valued at 2.59, which indicates is a large effect based on Cohen's (1992) guideline.

Overall Cognitive Skills: in response to the cognitive skills scores in the cognitive assessment scale between the pre and post-test, a simple paired t-test was administered to examine whether the cognitive skills training program increased cognitive skills between the pre and post-test scores in the pre and post-test Table-2. After the 12 sessions of the cognitive skill training program, a significant improvement was seen in cognitive skill scores on all the dimensions of cognitive skills.

Descriptive Statistics of Mean SD and Sample Paired t-Test of Cognitive Skills.

It was hypothesized that intervention in cognitive skills assumption was considered satisfactory. The results revealed significant differences among pre and post-test (before and after) scores for the intervention (all $p > 0.001$), suggesting that the dependent sample paired t-test is appropriate in this analysis. The result shows a significant difference in all the dimensions of cognitive skills in favor of post-test.

Table 3. Descriptive Statistics of Mean, SD, and Sample Paired t-Test Scores in Various Dimensions of Cognitive Skills of children with autism spectrum disorder (N=20)

Cognitive Skills Variables	Mean Pre	SD Pre	Mean Post	SD Post	Paired t-test Score
Recognizing familiar objects	2.40	0.50	4.00	0.56	-9.49
Match similar objects	2.10	0.30	4.15	0.36	-17.96
Follow instructions	2.10	0.30	3.80	0.52	-16.17
Make story	1.90	0.55	3.75	0.44	-14.09
Perform action	1.85	0.36	4.20	0.83	-15.66
Imitate others	2.00	0.32	3.65	0.48	-12.56
Describe and comprehend the situation in the picture	2.05	0.51	3.60	0.50	-9.13
Differentiate between two object	2.00	0.64	4.30	0.73	-11.89
Compare between two object	1.80	0.41	3.65	0.48	-16.90

Find similarities between two object	1.80	0.41	3.50	0.51	-9.48
Find missing part of the picture	1.65	0.48	3.55	0.51	-11.83
Join dots for completion of the picture	1.85	0.36	3.55	0.51	-10.36
Explain objects like flower	1.40	0.50	2.55	0.94	-5.51
Identifying various colours	1.90	0.30	3.60	0.75	-13.30
Placing objects in order	2.00	0.56	3.75	0.44	-8.59
Differentiate between two lethetic area	2.00	0.00	2.90	0.85	-4.72
Differentiate between precise significant to small	2.35	0.75	3.75	0.44	-6.65
Differentiate volumes of two jars/glass	2.15	0.36	3.45	0.51	-12.36
Understand direction (left and right)	1.85	0.36	3.70	0.57	-16.90
Categorized objects	1.70	0.57	3.80	0.41	-11.91
Sorting and resorting objects	1.70	0.47	3.85	0.36	-16.37
Differentiate length	1.80	0.41	2.85	0.85	-4.70
Follow directions	2.00	0.00	3.90	0.55	-15.37
Differentiate between distance (near and far)	2.10	0.30	3.45	0.51	-12.33
Draw house or men	2.25	0.55	3.90	0.30	-12.56
Recognizes various emotions	2.05	0.82	3.45	0.51	-6.65
Hits object from a specific distance	2.15	0.36	3.10	0.55	-7.02
Find hidden objects from the box	1.30	0.47	3.55	0.51	-12.79
Guess what inside the envelope	1.65	0.67	3.30	0.47	-9.90
Understanding others mental state	1.85	0.58	3.30	0.73	-6.17
Draw an unusual picture (imagination)	1.80	0.52	3.35	0.48	-10.10
Find a route from mazes (simple to complex)	1.15	0.36	3.30	0.47	-14.03
Make the connection between number and star (*)	1.65	0.48	3.35	0.48	-10.92
Place blocks in the right place	1.65	0.48	3.60	0.75	-11.57
Make patterns	1.75	0.44	3.30	0.57	-9.83
Find and put the block in the shape	1.95	0.60	3.45	0.51	10.10

Parents Perception on Overall Effects of Cognitive Skill Training Program: the parents' perception toward cognitive skills training program were seen by conducting a semi-structured interview and open ended-questionnaire, which was comprised of 10 questions about parent's perception and the effects of cognitive skills training program on cognitive functioning like improvement in functioning, the usefulness of the intervention, any fur-

ther direction and recommendation. All 20 parents believed that the cognitive skills training program showed a positive effect on children' cognitive skills that all of the children with ASD were benefited by participating in 12 sessions of the cognitive skill training program. After 12 sessions of intervention, a positive change was found in cognitive skills from participating in the cognitive training program, according to the perspectives of the parents

and children with ASD. Parents' perception of the intervention's usefulness that all parents reported this kind of program was very useful in improving the cognitive skill training program.

DISCUSSION

The present study studied the effects of the cognitive skill training program on children with ASD. The cognitive skill training module was developed to be suitable for educational services by using manual based activity program. The training targeted 6-12 year-old children. The development of cognitive intervention that can be easily conducted in educational program could be useful for enhancing cognitive skills and reducing cognitive deficits in children with ASD. This study revealed that the cognitive skill training program is effective in response to the improvement of cognitive skills. The effects of cognitive intervention module on cognitive deficits of children with ASD was analyzed children's cognitive skills were measured using the cognitive assessment test developed by the researcher. Analysis of the results showed the significant impact of the intervention on cognitive skills such as understanding, comprehension, application, synthesis, evaluation, conservation ability, planning ability, imitation ability, and working memory showed an increase in the test. There was a statistically significant positive change found in ASD children's cognitive functioning. A number of these beneficial changes have been supported in previous findings. The finding of the present study did confirm those found by Metcalfe, Harvey, and Laws (2013) stated that the cognitive functioning skills enabling a person's ability to think and apply acquired experiences might include various cognitive skills such as working memory, abstract thinking, visual processing, and processing speed. Further stated that individuals with ASD have an irregular pattern of cognitive abilities or skills. In the present research, it has been confirmed that after conducting tasks related to cognitive skills, ASD children have improved their working memory and planning ability, respectively. Borenstein and Ruppin (2005) imitation is a highly complex cognitive process it involves vision, perception, representation, memory, and motor control. The primary mechanism that gives rise to imitative and needs much attention to focus research in this area. Result reveals complex dynamics, combining innate perceptual-motor associated with acquired context action association to complete required tasks. These results indicate that the intervention had a significant effect on overall cognitive skills in children with ASD.

However, cognitive skills assessment test scores shown an improvement in all of the 32 cognitive skills variables namely recognizing familiar objects, match similar objects, follow instruction, make story, perform action, imitate others, describe and comprehend situation in picture, differentiate between two objects, compare between two objects, find missing part of the picture, join dots for completion of picture, identifying various color, placing object in order, differentiate between two leathetic area, differentiate between precise significant to small, differentiate volumes of two jar/glass, understand direction (left and right), categorized objects, sorting and resorting objects, differentiate length, follow directions, differentiate between distance (near and far), draw house or men, recognizes various emotions, hits object from specific distance, find hidden objects from small box, guess what inside the envelop, understand others mental states, draw a unusual picture (imagination), find route from mazes (simple to complex), make connection between number and star (*), Place shapes in right place, make patterns, find and put block in wooden tray. The result has supported the significant improvement that occurred in cognitive function.

CONCLUSION

After the cognitive skill training program, the results showed an overall improvement in cognitive skills. The study found significant improvements in planning, mental set-shifting, working memory, cognitive flexibility, and inhibitory control (Corbett, Constantine, Hendren Rock, and Ozonoff, 2009). However, the effects of the cognitive skill training program were little change in understanding cognitive mental states. Regarding the central coherence, an improvement was observed in the perceptual processing abilities. The parent's questionnaire responses indicated significant changes in the overall cognitive skills. The cognitive skill training program was found to be effective for improving the cognitive functioning of children with ASD. The cognitive skill training program is a purposeful design to improve cognitive function. It has also been noticed that this kind of training program needs to be conducted more or regular sessions for long-term effects on the cognitive ability of ASD children. It is concluded that cognitive skill intervention needs to be conducted in future research. Further, it also provided a structural design of the intervention in response to developing a more comprehensive training module for children with ASD and fulfilled the research gap in India.

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